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Membership Rates

Full membership in the Maryland Herpetological Society is $12.50 per year, subscribing membership (outside a 20 mile radius of Baltimore City) $10.00 /year, Foreign $12.00/yr. Make all checks payable to the Natural History Society of Maryland, Inc.

Meetings

The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

IN MEMORIUM

"DUKE"

Howard W. Campbell, Jr.

1935-1981

Words cannot express our loss at the passing of Duke Campbell. Duke was born in Baltimore and obtained his B.S. at the University of Florida, his M.S. and Ph.D. at the University of California with a hitch in the Army in between. Recently, he headed the Fish and Wildlife Service for the State of Florida. Those who knew Duke valued his friendship . . . he was always ready to help with our problems. His insight and creative mind coupled with scientific thought gave Duke an edge on most of us. He will be missed . . . .

Bulletin of the Maryland Herpetological Society

Volume 18 31 March 1982 Number 1

Single vs Multiple Predatory Strikes by Prairie Rattlesnakes *(Crotalus viridis)*

Barbara O'Connell, David Chiszar, and Hobart M. Smith

Abstract

Ten adult prairie rattlesnakes (*Crotalus viridis*) were offered two successive mice (*Mus musculus*, > 20 gm) during each of three feeding sessions (inter-session interval = 2 wks). Snakes almost always struck (i.e., injected venom) only once when they were attacking the first prey of each feeding session. When attacking the second prey, snakes emitted significantly more multiple strikes than when first prey were attacked. Latencies to strike first and second prey did not differ. Time for mice to become immobile following the initial strike did not differ for first versus second prey. Implications of these results for neural mechanisms regulating post-strike behavior of rattlesnakes are discussed.

It has frequently been reported that rattlesnakes strike, envenomate, and release rodent prey (see Chiszar & Scudder, 1980, for a review). Striking activates a high rate of tongue flicking which brings the snake into contact with the envenomated rodent's trail and allows the snake to follow it with precision (Dullemeijer, 1961; Gillingham & Clark, 1981; Golan et al., under review). Once a rattlesnake delivers a successful predatory strike, the snake will usually not strike the same rodent again (Chiszar et al., 1977, 1978) even though the rodent wanders about the snake's cage for an average of 78 seconds before succumbing to the venom (Estep et al., 1981). This "strike-induced inhibition against subsequent strikes" has been observed several times (Chiszar et al., 1977, 1978; Radcliffe & Chiszar, 1980; Scudder, 1982), but other workers have seen rattlesnakes deliver multiple strikes in rapid succession to the same prey or to sequentially presented prey (Gillingham & Baker, 1981).

We have noticed (unpublished observations) that captive prairie rattlesnakes are more likely to emit multiple predatory strikes after they have envenomated and ingested one mouse and are dealing with their second rodent prey. Multiple strikes delivered to second or subsequent prey may indicate that the snake's strike-releasing mechanism is

Key Words: Reptilia, Serpentes; *Crotalus*, predation; envenomation.

sensitive to the venom supply and/or to amount of venom injected per strike. If such prey receive less venom per strike than first prey, then multiple strikes may be required in order to deliver an effective dose (see Klauber, 1956, and Kochva, 1978, for reviews of venom injection). Since these ideas have important implications for our conceptualization of neural feedback arising from predatory strikes, the present study was designed to gather relevant data under controlled conditions.

Method

Ten adult prairie rattlesnakes (*Crotalus viridis*) were maintained in individual glass terraria (50 x 27.5 x 30 cm) at 26-28^{o}C during the light period (0800-2200) and at 22-24^{o}C during the dark period. All had been in captivity (and accepted rodent, *Mus musculus*, prey on a weekly schedule) for at least one year. Although the snakes had been used in previous experiments involving presentation of chemical stimuli, no surgical or pharmacological manipulations had been performed. Hence, we consider these snakes to be typical of long-term captives. On a regularly scheduled feeding day an adult mouse (*M. musculus*, > 20 gm) was dropped into a snake's cage as usual, and we recorded the number of times the mouse was struck. Five minutes following ingestion of this prey, a second live adult mouse was introduced and we again recorded the number of strikes it received. This entire procedure was repeated two and four weeks after the initial feeding session. Hence, each snake killed and ingested six prey in this study. Records were also kept of the latency for each snake to strike each mouse (first strike to each mouse, as well as intervals between repeated strikes), and the length of time each mouse remained mobile after receiving the first strike.

Results

When snakes were attacking their initial mouse of each feeding session, the average number of strikes was 1.06. In 30 such trials, 29 involved a single strike, and only 1 involved multiple strikes (3). When snakes were attacking their second prey, the average number of strikes was 1.33. In 30 trials, 19 involved a single strike whereas 10 involved 2 strikes and 1 involved 3 (average inter-strike interval in all cases of multiple strikes was 73.6 seconds; SD = 79.5, SEM = 22.0). The increase in the number of trials involving multiple strikes (first vs second mice) was significant by sign test ($p < .05$). Similarly, the mean number of strikes delivered to first prey was significantly lower than the mean delivered to second prey ($t = 6.71$, $df = 9$, $p < .01$).

Mean latency to strike was 80.8 sec (SD = 172.9; SEM = 21.1), and this mean did not differ significantly for initial vs second prey ($t = 1.90$, $df = 29$, $p > .05$).

Mice that were first prey remained mobile after envenomation

for an average of 55.3 sec (SD = 81.1; SEM = 14.81); the mean was exactly the same for mice that were second prey ($\bar{x}$ = 55.3, SD = 86.0, SEM = 15.7).

The 19 second prey that were struck only once remained mobile for an average 32.4 sec (SD = 23.4; SEM = 5.3) whereas the 11 that were struck more than once had a mean of 94.7 sec (SD = 133.3; SEM = 40.1). The difference between these variances was significant ($F = 32.41$, df = 10/18, $p < .01$). So, procedures recommended by Cochran and Cox (1957) and Ferguson (1981) were used to test the significance of the difference between these means. The difference was not reliable ($t = 1.57$, df = 28, $p > .05$).

Discussion

Prairie rattlesnakes tend to deliver multiple predatory strikes to the second mouse of a feeding session but not to the first. After snakes delivered two or three strikes to the second mouse, subsequent predatory behavior was indistinguishable from that described in previous reports (see Chiszar & Scudder, 1980, for a review). Strike-induced chemosensory searching was initiated and no further strikes were delivered while the snake was attending to chemical cues. Only rarely did snakes depart from this behavioral sequence (on 2 trials involving second mice, snakes struck twice and held the mice in their jaws after the second strike; see Allon, 1973; Gans, 1966; Radcliffe et al., 1980).

If it is assumed that multiple strikes involve multiple injections of venom (or injections at least during the last strike), then it can also be suggested that rattlesnakes require multiple injections to achieve comparable envenomation effects in the second mouse as were achieved in the first one. The most important implication of this assertion is that rattlesnakes are sensitive to the amount of venom injected during a strike and this information can be used to release multiple strikes when these are necessary. This idea is consistent with some data on quantity of venom injected by snakes as a function of type and size of prey (Gennaro & Ramsey, 1959; Gennaro et al., 1961), but findings by Kochva (1960) with *Vipera palaestinae* do not confirm the hypothesis that the second mouse (struck once) necessarily receives less venom than the first mouse. However, subsequent mice (each struck once) received far less venom than the first mouse (see Kochva, 1978, for a review). Hence, the literature indicates that amount of venom injected is influenced by the amount of venom remaining in the glands just prior to the strike. Relative effects of declining values of these factors on emission of multiple strikes can be assessed only by experiments which manipulate amount-of-venom-injected orthogonally with venom supply.

It might be argued that multiple strikes are delivered because the prey has not succumbed to venom and is still mobile. Such a view

must explain why snakes did not deliver multiple strikes to the first mouse of the feeding session. These mice remained mobile after envenomation for the same average length of time as second mice (55 sec), and both mice frequently moved within striking range during this period. Accordingly, we suggest that stimulation arising from a moving mouse cannot be the only factor governing release of multiple predatory strikes. It has been hypothesized (Chiszar et al., 1977, 1978) that delivery of a lethal dose of venom results in strike-induced inhibition of further strikes (SIIS) and in strike-induced chemosensory searching (SICS). However, a sublethal dose, as may occur when a snake has recently expelled venom and therefore had a reduced supply, may not produce either of these phenomena. Hence, the snake remains sensitive to strike-releasing stimuli and is capable of executing additional strikes. It is here suggested that when a sufficient dose of venom has accumulated over multiple strikes, SIIS and SICS are initiated, and the snake switches its attention to trail-related chemical cues. This view argues that proprioceptive stimulation arising from the skeletal mechanics of striking (e.g., jaw and neck movements) are less important for initiation of SIIS and SICS than stimulation associated with volume of venom injected into prey and/or the volume of venom remaining in the glands.

In any case, rattlesnake post-strike behavior differs systematically depending upon whether the snake is dealing with its first or with subsequent prey. These differences must be incorporated into our view of sequential relationships between component responses that comprise the predatory pattern of these snakes (cf. Gillingham & Baker, 1981; Chiszar et al., 1980, 1981).

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The Enigma of *Anolis cooperi* Baird:

A Taxonomic Opinion Regarding Its' Status and Usage

Thomas Vance

The year 1858 brought about a perplexing problem regarding the systematics of the mammoth sized lizard genus *Anolis*. The concept of a new taxon appearing in print, but one which is of questionable identity and existence, adds another name to the overly burdened group of anoles which exhibits over 300 currently recognized taxa and with an estimated number of over 500 occupied names. The species in question is *Anolis cooperi*.

Described as a new species in 1858, Spencer F. Baird provided the description as:

> "Cephalic scales smooth. Inter-orbital ridges running to the side of the rostrum, posterior to the nostrils which are rather lateral. Digital pallets inconspicuous. A few central dorsal rows of scales abruptly larger than the rest, but the lateral all much smaller than the ventral. General color grayish above. Less than *A. carolinensis*."

The type locality ("habitat")was given as "California", the collector as Dr. J. G. Cooper, and the museum number of "4165" in the United States National Museum. Although several reports have appeared and recording specimens of *Anolis* from the state of California (Yarrow, 1883, p. 71 and Cope, 1900, p. 237), it has never been properly considered to be within the natural range of these lizards.

Grinnell and Camp (1917) used *Anolis cooperi* as a synonym of *Uta graciosa* and used "Cooper's Green Lizard" as a common name in their California checklist. Van Denburgh(1922) retained *cooperi* as a synonym of *U. graciosa*, but he questioned this usage as well as the type locality. Baird (1859) had listed a *Uta graciosa* from California the year after his description of the anole, in annotated form and without mention of it. He was seemingly knowledgeable of *Anolis* and *Uta*, as evidenced by his published accounts, which makes the idea of mistaken generic identities remote. The lizard of Grinnell and Camp (1917) and Van Denburgh is presently known as *Urosaurus graciosus* (Collins, et al., 1978).

That Cope (1862) had the holotype in front of him is unquestionable due to the fact that he compared certain unreported features of it against his newly named *Anolis (Gastrotropis) radulinus* and *Anolis (Gastrotropis) concolor*. His description is partly quoted as, "*Sallaei*,

cooperi and *cupreus* resemble it (referring to *radulinus*) in form, but all have larger frontal and muzzle plates: in *sallaei* the large dorsal rows of scales are more numerous." His second reference to *cooperi* is, "*A. cupreus* Hallow. is nearly related to *A. cooperi* Baird, both differing from *A. sallaei* in the less number and uniformity of the rows of keeled dorsal scales. In *cooperi* the first infralabial is large as in *sagrae*, and there is a strong prebrachial fold. The palpebrals are three or four-rowed."

The taxonomic history continued when Cope (1875) listed *A. cooperi* as a recognized species, but he questioned its' occurrence in California. Garman (1884) followed the previous reports by listing the state as the correct locale. Boulenger (1885) had followed the same course, but later (1888) listed this species as occurring east of the Mississippi River.

Yarrow (1883) may have been responsible for Boulenger's later decision when he listed another individual specimen, thought to be *cooperi*, from "Cape Punta, Florida" which was catalogued in the United States National Museum as number 6002. Cope (1900) failed to mention this particular species when his classic checklist was published. Barbour (1931) relates that Yarrow's specimen was not Baird's specimen, but rather it was named as a new and undescribed species. He christened it as *Anolis stejnegeri* and used the specimen of Yarrow as the paratype and a specimen from the Museum of Comparative Zoology as the holotype. Barbour also produced the recorded entry of Baird's specimen from a personal letter by Leonhard Stejneger as, "4165. *Anolis*-California. Dr. Cooper. 2 (meaning 2 specimens). Found in bottle of *Scelop. occidentalis* from Calif. 2871." As might be expected, he questioned the California recording and reported that the specimens were lost from the United States National Museum.

The next mention of *A. cooperi* comes from Smith and McCauley (1948) as they compared certain criteria from literature with their newly named *Anolis distichus floridanus*. They reasoned that *cooperi* may represent a Floridian species but had lacked the evidence to support their decision. Neither Cochran (1961) nor Malnate (1971) listed the holotypes in their catalogues of type specimens in the Academy of Natural Sciences or the U.S. National Museum.

Comparisons of the above mentioned characters with the features of other reported *Anolis* has determined that *Anolis cooperi* shares similar features with: *A. sabanus*, *A. luciae*, *A. vincenti*, *A. poncensis*, *A. darlingtoni*, *A. bahorucoensis*, *A. onca*, *A. pentaprion*, *A. utowanae*, *A. cymbops*, and *A. liogaster*. There is also the likelihood that Baird based his description on a composite of two species which may have been closely related.

Ms. Catherine Blount of the U.S. National Museum has verified

the absence of the *Anolis* from the collection. She has verified that the specimens of USNM 2871 are actually *Sceloporus occidentalis* from California. These specimens are reportedly to have been collected by Governor Stevens and prepared by Dr. Cooper. The available records which list Dr. Cooper's travels do not shed any additional light on this situation, however they are classified as Archives number 7067, box number 1.

Thus, the current information leads one to conclude that *Anolis cooperi* of Baird cannot be readily placed into synonomy with any particular or currently recognized species of anole. The description was not sufficient to provide enough information to substantiate it as a distinct species. The types are lost (or possibly non-existent), and the type locality is no doubt an error. Therefore, the author is of the opinion that *Anolis cooperi* Baird (1858) should be considered as a *nomen dubium* until future answers can provide evidence to the contrary. Only the examination of the original type specimens can shed insight as to the correct identity, however the exact collection locality may never be known.

ACKNOWLEDGEMENTS

The author is appreciative of the efforts of Catherine Blount of the U.S. National Museum for generous cooperation and investigations. Bill Rushing of Navarro College proofread this report for grammatical errors. Hobart Smith of the University of Colorado proofread the report for taxonomic and grammatical errors. Lanall Brown typed the manuscript.

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REGENERATION OF A LIMB IN THE SPOTTED SALAMANDER

(*Ambystoma maculatum*)

An adult spotted salamander, *Ambystoma maculatum*, was found in a ditch at Essex Junction, Vermont, on 9 September 1981. It was found by Elery Geirard, a construction contractor, 12 feet underground while laying sewage line. It is unknown whether the animal tumbled into the ditch from the surface or was excavated during the digging. The frost line in Vermont reaches a depth of about 6 feet.

The salamander, which is still alive at this writing, is an adult measuring about 7 inches in total length. For the first few weeks, the salamander survived well in captivity, feeding on various insects and spiders. The terrarium it was kept in became excessively dry and the salamander's left front leg adhered to the terrarium floor and was severed at the body. During the first few weeks after losing its leg, the animal refused to eat and became very nervous - almost going into convulsions when handled. After about a month, it began feeding on various insects found around the house, showing a great preference for live spiders. Following two more months of infrequent handling, adequate diet, and spring water, the left front leg was noticed to be two thirds regenerated. Presently, the leg has regenerated to about three fourths of its original length. The foot and toes have yet to appear. For the past month, the salamander has been feeding well on red worms and night crawlers.

Published data show that newts (*Notothalmus*) have the ability to regenerate limbs and tails, and that many types of salamanders may also regenerate limbs. One account indicates that an *Ambystoma maculatum* regenerated part of a lost foot and toes, and many recent studies show that regeneration of toes clipped at the breeding ponds can occur in one season for this species.

I would like to thank Samuel and Jason Dammann for help in making observations and caring for the salamander in my absence, and Dr. Don Forrester for encouraging me to prepare this note.

—John Donald Cochran, *Maryland Herpetological Society, Natural History Society of Maryland, 2643 N. Charles Street, Baltimore, Maryland 21218*

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Accepted 4 February 1982

NEWS AND NOTES:

EASTERN SEABOARD HERPETOLOGICAL LEAGUE

TENTH YEAR ANNIVERSARY MEETING

20 MARCH 1982

Sponsored by:

The Maryland Herpetological Society
Department of Herpetology
The Natural History Society of Maryland
2643 N. Charles Street
Baltimore, Maryland 21218

Hosted by:

The Maryland Science Center
601 Light Street (Light Street & Key Highway)
Baltimore, Maryland 21230

PROGRAM AND ABSTRACT OF PAPERS:

10:00 - 11:00 a.m.	Registration and Refreshments
11:00 - 11:30 a.m.	Opening Remarks
11:30 - 12:00 Noon	"Facelift for an Old Reptile House" Mr. Robert B. Davis, Department of Herpetology, National Zoological Park, Washington, D.C. 20008
12:05 - 12:50 p.m.	"Infrared Receptors in Snakes" Dr. Richard M. Meszler, Ph.D., Department of Anatomy, University of Maryland Dental School, Baltimore, Maryland 21201
1:00 - 1:45 p.m.	"Sexual Selection in the Spring Peepers, *Hyla Crucifier*: Role of the Advertisement Call", Dr. Don C. Forrester and Mr. Richard Czarnowsky, Biological Sciences/Institute of Animal Behavior, Towson State University, Towson, Maryland 21204
1:50 - 2:50 p.m.	"The Medical Management of Reptiles" Dr. Michael K. Stoskopf, D.V.M., Assistant Professor Division of Comparative Medicine, Johns Hopkins School of Medicine, 720 Rutland Avenue, Baltimore Maryland 21205 <u>and</u>

	Head of Department of Medicine, National Aquarium in Baltimore, Pier 3/501 E. Pratt Street, Baltimore, Maryland 21202
3:00 - 4:00 p.m.	LUNCH BREAK
	(Note: At this time, ESHL representatives are asked to report to the front of the auditorium for a brief meeting.)
4:00 - 5:00 p.m.	"The Desert Tortoise - Long Term Problems with No Easy Solution", C. Kenneth Dodd, Jr., Ph.D., Staff Herpetologist, Office of Endangered Species, United States Department of the Interior, Fish and Wildlife Service, Washington, D.C. 20240
5:10 - 5:40 p.m.	"Antibiotics as a Treatment for Some Reptilian Diseases", Dr. Mitchell Bush, D.V.M., Head of Department of Animal Health, Hospital, National Zoological Park, Washington, D.C. 20008
6:00 - 6:45 p.m.	"An Investigation of Maryland Endangered Herptiles", Mr. Gary Taylor, Nongame and Endangered Species Program Director, Maryland Wildlife Administration, P.O. Box 68, Wye Mills, Maryland 21679
7:00 - 7:30 p.m.	"The Turtle Trust" and "Registration of Herptiles" Mr. Richard C. Paull, Trustee, Turtle Trust, Westport Point, Massachusetts 02791

ABSTRACTS

FACELIFT FOR AN OLD REPTILE HOUSE.

Davis, Robert B., Department Herpetology, National Zoological Park, Washington, D.C. 20008

The Reptile House at the National Zoological Park, built in 1931 and referred to as a historical structure by the Fine Arts Commission in Washington, D.C., has undergone a facelift. Many believe that this facelift has made this reptile house the finest reptile house in the United States. In addition to this facelift a herp lab, which will be briefly talked about today, funded by a $200,000 National Science Foundation grant, incidentally the largest grant for this type of education program ever given, is in development. The construction is largely cosmetic in the visitor area, but the overall organization embraces the basic philosophy that there should be larger groups of animals, of fewer species. This allows for a more natural setting, evident by the all

natural plants in the exhibit and the lack of concrete. Secondly, the all natural settings, fewer species and redesign of some cages caters to an environment more conducive to breeding, which will be more and more important as natural habitats are destroyed. Also added is an indoor/outdoor crocodile exhibit. The grant also provides for the work of two fulltime people over a period of three years to come up with a reptile-amphibian educational program for the general public. If successful, this program will be used by several other zoos. Besides talks and programs, the herp lab will let people explore such things as snake skins and turtle shells and the public will even have the opportunity to come eye to eye with some live reptiles and amphibians. Also a rare, fossilized triceratops skull will be on exhibit.

Today's slide show will take you on a "private tour" of the National Zoological Park's new Reptile House.

INFRARED RECEPTORS IN SNAKES

Meszler, Richard M., Department of Anatomy, University of Maryland School of Dentistry, Baltimore, Maryland 21201.

Two families of snakes, the Crotalidae and the Boidae, have a unique warm (infrared) sensitive thermoreceptor system that enables them to detect a radiant heat source with a temperature as little as approximately 0.5°C above background. It is probable that the system evolved independently in each family. The apparent adaptive value of this receptor system is that it provides these snakes with an advantage in two important areas, obtaining food and thermoregulation.

It is well known that a warm object excited the interest of a rattlesnake and may incite what appears to be a strike reflex. The receptor is an energy detector sensitive to wavelengths of 1 to 10 microns. The sensitivity of the system (2×10^{-5} caloris per square centimeter) is sufficient for a snake to be able to detect the infrared radiation of warm-blooded prey. It is also possible that the snake uses the receptors to scan the environment to find a place with a suitable temperature as part of their behavioral mechanism for thermoregulation.

The gross morphology of the thermoreceptors varies in the species. In the pit vipers the receptor consists of a pair of facial pits each of which contains a thin, highly innervated cutaneous membrane suspended across the opening. Tree boas and pythons have labial pits along the jaws. The nerve endings are localized just under the surface of the skin within the floor of these pits. Other boas have not pits, but have similar thermosensitive nerve endings in the facial skin.

In all species, the receptor terminals themselves are bare nerve endings that splay out from a palmate knob at the end of the nerve fiber. In

the pit vipers, these terminals seem to form individual clusters which appear to represent individual points on a sensory grid. This sets up a pattern for point-to-point or spaciotropic representation in the snake brain.

The innervation to the pits comes from the main sensory nerve of the face, the trigeminal nerve. These specialized thermoreceptor nerve fibers convey the sensory impulses to a separate relay nucleus in the brain (the lateral descending nucleus of the trigeminal nerve) that is unique to the Crotalidae and Boidae. The thermoreceptor input is then passed along to other areas of the brain. One of the most interesting of these sites is the optic tectum in the midbrain. This is a part of the brain primarily concerned with vision. It has been determined in the pit vipers, that there is integration of the inputs from the two receptor systems.

This provokes some interesting speculation. The diameter of the opening of the facial pit is considerably less than that of the pit membrane and the effective wavelengths are large, so the pit could act as a primitive pin-hole camera. This taken into consideration with the grid pattern arrangement of nerve endings in the pit membrane, the spaciotopic organization of the system within the brain and the convergence of the thermoreceptor and optic input suggests that these snakes may have an effective visual capability that includes infrared.

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SEXUAL SELECTION IN THE SPRING PEEPER, *HYLA CRUCIFER*: ROLE OF THE ADVERTISEMENT CALL

Forrest r, Don C. and Richard Czarnowsky, Biological Sciences/Institute of Animal Behavior, Towson State University, Towson, Maryland 21204

The spring peeper is a prolonged breeder. Males select a calling site and emit a single-note, advertisement call. Spectrographic analysis reveals intra-population variation among each of several call components: (1) intensity, (2) repetition rate, (3) length, (4) carrier frequency. Laboratory discrimination trials were conducted to determine female preference for one form of the same call differing in intensity or repetition rate alone; as well as the same call differing by a combination of both characters. During separate experiments, females exhibited a preference for speakers which emitted the loudest call or the fastest call. During trials involving combined characters, females overwhelmingly selected loud, fast calls in preference to quiet, slow calls. Females also preferred (but to a lesser degree) loud, slow calls to quiet, fast calls. Contrary to published reports, females did not exhibit a preference for calling males based on their body size.

THE MEDICAL MANAGEMENT OF REPTILES

Stoskopf, Michael K. Assistant Professor, Division of Comparative Medicine, Johns Hopkins School of Medicine, 720 Rutland Avenue, Baltimore, Maryland 21205, and Head of Department of Medicine, National Aquarium in Baltimore, Pier 3/501 East Pratt Street, Baltimore, Maryland 21202.

Reptiles are subject to a wide variety of medical problems. The prompt recognition of signs and symptoms is of paramount importance to successful therapy. Proper management and environmental control can alleviate a number of problems and aid in the detection of others. The interrelationships between these clinical approahces will be explored as they relate to a number of common syndromes.

THE DESERT TORTOISE -- LONG TERM PROBLEMS WITH NO EASY SOLUTIONS.

Dodd, Jr., C. Kenneth, Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, D.C. 20240.

During the last decade, there has b-en increasing concern about the viability of desert tortoise, *Gopherus agassizii*, populations in the United States. This concern has centered on the threats to the habitat of the species, coupled with biological attributes such as low reproductive replacement rates, which make the species vulnerable to perturbations in its environment and population structure. Until recently, the status of individual populations has been poorly understood and speculative. Funded largely by the Bureau of Land Management and resident states, extensive research has now shown past concern to be justified. The desert tortoise, it turns out, is not always what it seems. For instance, the species is often perceived as continuously distributed from southern Utah to northern Sinaloa, Mexico. Analysis of populations, however, reveals a variety of distribution patterns. In California and Nevada,

tortoises are nearly continuously distributed in densities of from less than 5 to approximately 250 per square mile. In Arizona and perhaps Mexico, populations are much more scattered giving a distinct "island" pattern of distribution; densities are very low. Even in "good" populations (in terms of numbers), age structure and sex ratios may vary widely within relatively short distances thus indicating stress and fragmentation. And since the tortoise is long lived, the problems we see now may have resulted from events that occurred long in the past and may take decades to correct. The main threats to the tortoise include population fragmentation and its resulting effect on population structure (for instance, small effective number of breeding adults); competition from grazing livestock for forage and destrubtion of habitat (cover sites, burrows, browse plants) and individuals (through trampling) by such livestock; off-road vehicle habitat destruction; surface mining and energy related exploration; land development for residential, industrial, agricultural, and military (MX) purposes; collected as pets; predation and disease in already small populations; vandalism; and inadequately enforced federal, state, and local regulations. In fact, the problems facing the tortoise are a microcosm of the problems facing humans and the development of the arid West. There are no simple solutions to tortoise conservation, only hard biological facts and difficult management decisions. Tortoise habitat MUST be protected if the species is to survive. And how we deal with the conservation of this amiable species will say much about our society and its environmental ethics. But do we have the time?

ANTIBIOTICS AS A TREATMENT FOR SOME REPTILIAN DISEASES

Bush, Mitchell, Head of Department of Animal Health Hospital, National Zoological Park, Washington, D.C. 20008

No Abstract Received.

INVESTIGATION OF MARYLAND ENDANGERED HERPTILES

Taylor, Gary, Nongame and Endangered Species Program Director, Maryland Wildlife Administration, P.O. Box 68, Wye Mills, Maryland 21679

The Maryland Wildlife Administration's Endangered Species program has done extensive work investigating the endangered reptiles and amphibians indigenous to the state of Maryland. They have studied the behavior, habitat and population of a host of species including the Muhlenberg bog turtle *Clemmys muhlenberg*; the Hellbender *Cryptobranchus alleganiensis alleganiensis*, the Jefferson salamander *Ambystoma Jeffersonianum*, the Eastern tiger salamander *Ambystoma tigrinum tigrinum*, the Green salamander *Aneides aeneus*, the Northern Coal Skink *Eumeces anthracinus anthracinus*, and the Mountain earth snake *Virginia valeriae pulchra* in an attempt to identify those populations that are in danger of becoming

extinct. From their studies, further work can then be done to bring the populations of those identified species up to a safe unendangered level.

THE TURTLE TRUST

Paull, Richard C., Trustee, Turtle Trust, Westport Point, Massachusetts, 02791

The Turtle Trust is a charitable trust for the protection of turtles, especially through captive breeding.

REGISTRATION OF HERPTILES

A proposal for the private registration of amphibians and reptiles, especially endangered threatened species.

The following is printed here as background material and was taken from THE ESHL NEWSLETTER, November 30, 1981:

PROPOSAL FOR THE PRIVATE REGISTRATION OF AMPHIBIANS AND REPTILES, ESPECIALLY ENDANGERED AND THREATENED SPECIES

The recent "Sting' operation conducted by the U.S. Fish and Wildlife Service has caused private collectors of amphibians and reptiles to question how they would prove that the threatened or endangered species in their collections had been legally acquired. As we well know, many such animals are traded or bought and sold by private collectors without documentation. Many reptiles and amphibians are collected in the wild or result from captive breeding. If after that time such animals are protected by state or federal law, the owner would be hard pressed to provide that they had been legally acquired. "Snakescam" will undoubtedly halt the traffic in illegally acquired reptiles - at least temporarily; but, unless steps are taken to protect the private collector, captive care and propagation of threatened and endangered species will receive a setback from which it may never recover and the laws which seek to protect endangered and threatened species may result in their extinction. Further, unless threatened and endangered species are available legally, the black market will resume due to the high prices that can be obtained.

Dogs, cats, horses, and other animals have been registered by private organizations and such 'papers' are accepted as proof of legal ownership. Why not reptiles and amphibians? While there are prerequisites that would have to be fulfilled before registration of reptiles and amphibians would be feasible or accepted by public as well as private collectors, a mechanism to protect private collectors - as well as

purchasers - must be established. No one can fault the objectives of Fish and Wildlife in undertaking 'Snakescam'. However, their means and methods of obtaining their objectives appear to have violated legal as well as ethical standards. As a result, instead of the legal presumption of innocent until proven guilty, the owner of a threatened or endangered species finds himself in the position of having to prove that such species were not acquired in violation of a state or federal law - laws which are not made known to collectors or the general public. Avenues of communication between state and federal agencies and public and private collectors must be established. A private registration agency could be that avenue of communication.

Before private registration could be established, two areas would have to be negotiated with state and federal officials: Confidentiality of registration records and the "grandfathering" of specimens in private and public collections. Practically, no one will provide information until such information could be protected, unless disclosed by the person providing the information originally. Unless both state and federal agencies would agree, in writing, to respect the confidential nature of the registration agency and further agree to accept registration 'papers' as proof of legal ownership, registration would not be feasible.

Further, threatened and endangered specimens must be grandfathered in and their legal possession acknowledged without further proof if such specimens are registered before the established date. While it is possible that some illegally acquired reptiles and/or amphibians would be legalized by such a concession, it would be the purchaser - who may have been unaware of the status - and not the poacher or wholesaler who would be protected. Moreover, it would be the collector who may have acquired the animal prior to its protection or acquired it through captive breeding who would obtain the most protection. And after the grandfather date, only those specimens acquired through a registered captive breeding or captured pursuant to the registered permits would be registered; future purchasers would have the protection of obtaining 'papers' when the specimen was acquired.

While these concessions would have to be negotiated, there are benefits to the state and federal agencies involved. Their input concerning registration regulations would recieve due consideration. Further, the registration agency could agree to release information of a general nature - such as the number originally registered, new registrations (which would be captive breedings), and number released, etc. Such information which has not heretofore been available, would be of great assistance to federal and state agencies should they seek to determine the status of any endangered, threatened or near-threatened species.

Another factor in the negotiations would be publish pressure regarding the activities of 'Snakescam' and the fact that Fish and

Wildlife has done little -- if anything -- to facilitate legal means of acquisition. In its press conference on 'Snakescam', Alan Levitt, spokesman for the U.S. Fish and Wildlife Service, stated:

> "Many people collect colorful exotic pets, such as snakes and birds, many of which must be caught illegally. He said the snakes sold unlawfully are virtually always bought by collectors - not for their skins or for snake cult religious purposes. The illegal sales are driving some species to extinction. The Eastern indigo snake from Florida has been on the endangered species list for three years because it's been collected almost into extinction."

Mr. Levitt failed to mention pollution, habitat destruction, rattlesnake roundups, or common ignorance as contributing causes. Later he did say many people legally collect snakes and other reptiles. Perhaps Fish and Wildlife could achieve its objective of protection by working with, rather than against, private collectors.

The proposed registration is not intended to circumvent federal or state laws covering threatened or endangered species but rather supplement such laws while protecting the private collectors as well as the animals. While a private intrastate transaction concerning an endangered species might not be subject to state or federal law (for example, the sale or trade of a hatchling Eastern indigo from the mating of Pre-Act parents), the new owner, upon receiving the registration 'papers", would be assured that his possession was protected and that the snake had not been illegally acquired. If questioned by a state or federal official, the presentation of the registration papers would be conclusive proof of legal possession. If, however, the purchaser desired one, or if federal law required one for transportation of specimens across state lines, a federal permit could still be obtained.

The primary benefit of registration, however, would be for the reptiles and amphibians. At present, due to the uncertainty of the intentions of the Fish and Wildlife Service, reptiles whose legal possession cannot be proven are in limbo. It is documented that reptiles are being destroyed, released under circumstances wherein their survival is extremely doubtful, or are being given away so that their owners will not have to face the wrath (or the penalties) of Fish and Wildlife if they cannot prove legal possession. Articles concerning captive care and propagation of threatened and endangered species are being withheld from publication because the owners, although they legally acquired the specimens in question, did not need permits and do not want to call the attention of the Fish and Wildlife Serive to their activities and risk the embarassment of being 'busted' and the cost required to prove their innocence.

Therefore, unless a system of establishing legal possession of currently held, as well as subsequently acquired, reptiles and

amphibians, is established and recognized, captive care and propagation will be hampered. Moreover, upon the establishment of registration, the increased availability of reptiles and amphibians through legal channels will lessen the incentives to illegally capture threatened and endangered species, thereby protecting existing populations. In addition, with increased dissemination of information, captive breeding will be expanded and existing populations increased by an organized release program. With the guarantee of a self-policing registration agency, perhaps the Fish and Wildlife Service can turn its attentions to preservation of habitat and the apprehension of the poachers and their wholesale purchasers!

REGISTRATION PROCEDURES

The Registration Agency

A non-profit agency should be established to act as the agency for the registration of reptiles and amphibians. This organization, which could be named the American Herpetological Association, would initially receive funding from other herpetological societies, foundations, private individuals, etc. Later, the organization would be self-supporting from registration fees and memberships. A Board of Directors, composed of representatives from herpetological societies, would establish the policies and procedures of registration and elect the officers who would be responsible for the day to day registration operation. Additional activities of the American Herpetological Association ('AHA') would include the establishment of sectional memberships and committees whereby collectors could join a group dedicated to the study and propagation of a specific reptile or amphibian, and compile and exchange information. Each section would report annually. In addition, the section would report proposed changes in state of federal laws to its membership and review and comment on proposed legislation. Further, the section might engage in lobbying or propose legislation to federal or state agencies. Another activity could be the establishment of breeding loan programs and the coordination with zoos with respect to the handling of surplus specimens; AHA could be the mechanism to stop the destruction of surplus populations that result from institutional policies and procedures. AHA could also identify habitat areas and lobby for the inclusion of such areas into wildlife sanctuaries.

Establishment of Registration Procedures

The first step in establishment of registration procedures would be the commencement of negotiations with the U.S. Fish and Wildlife Service and state agencies. The procedures and benefits of the registration process would be explained; concurrent with such negotiations would be a letter-writing campaign to congressmen and senators asking their assistance with state and federal agencies. Once an agreement was

reached, deadlines for the grandfathering in of each species would be established and disseminated nationally.

In establishing the mechanics of registration, the registration procedures of the American Kennel Club, American Cat Fanciers Association and other similar organizations would be reviewed. AHA procedures would incorporate their best features including the establishment of a 'book' for each classification. A prefix number for each species would be the same as the 'book' number and a second number would identify the specific animal. The information to be provided would include the scientific and common name, sex (if known), approximate age, date acquired, any special characteristics of the specimen (albino, melanistic, defects, etc.) and the name and address of the owner. If the application complied with the AHA regulations, a registration certificate would be provided; however, the only date listed thereon would be the date of registration. For example, an Eastern indigo snake would be registered as 201 (*Drymarchon corais couperi* Classification number)-103 (individual registration number). The registration certificate would include the pertinent information and the date of registration, which would prevent a registration certificate from being used to cover an unregistered animal. Upon the trade, sale, or loan of a registered animal, the certificate would be returned to AHA and a new certificate issued to indicate the new owner.

A system of 'clutch' registration would be established to cover captive breeding situations. This registration certificate would include the numbers of the parents, date of birth, and breeder's name. A number would be assigned to each offspring and the identification data could be provided at a later date.

Priority of Registration

While all reptile and amphibian classifications would eventually be registered, priority of registration would commence with endangered speices and a realistic grandfather date would be established for each. Threatened species would be registered after endangered, and then near-threatened species. Thereafter, other species would be registered on an optional basis because no grandfather date would be needed. This optional registration would be useful in protecting prospective purchasers and would be invaluable in captive breeding programs so that bloodlines could be traced for the purpose of line breeding or outcrossing.

In the long run, 'Snakescam' may well turn out to be a blessing in disguise. It is time that private collectors join together and present their viewpoints; as a silent minority, we have taken the blame for the status of many reptiles or amphibians. Moreover, the U.S. Fish and Wildlife Service has been able to mislead and harass individuals with impunity. Permit applications gather dust on officials' desks - and non-refundable application fees deter permit applicants. Further,

proposed and current laws and regulations are not readily available. There is much to be done in dealing with state and federal agencies, the media, and the public. The establishment of a national registration agency would be the start.

Volume 18, Number 1 March 1982

NEWS & NOTES

The following is an open letter to all Herpetologists and Herpetological Societies:

OUR LEGAL RIGHTS AS HERPETOLOGISTS??

Now that the dust has settled around the sting operation, and we have all had the chance to stand back and evaluate our future in keeping reptiles, it is clear that we have two paths to take.

The first choice is to go into hiding! We can remove our names from Herpetology Societies, destroy our records, euthanize questionable animals, and I dare say, let the U.S. Government legislate away our legal right to keep and breed reptiles.

Our second choice is to "get organized"! We are better prepared to organize now than at any time before. We have local Herp. Societies in almost every state and major city in the country. We can combine our efforts and:

1. Develop a National Certification program.

2. Establish Pedigrees on the offspring of legally obtained reptiles.

3. Combine the efforts between private, commercial and zoological collections.

4. Provide updates on National and State Law Making, to all participants.

5. Draft proposals for laws and regulations and make them available to Governmental Agencies such as Legislators, Fish and Game, etc.

In this way we can begin working with the Government in protecting and increasing our right to keep and propogate reptiles. If you are interested in the LEGAL RIGHTS OF HERPETOLOGISTS, please contact me, and your local Herp. Society.

Richard John Fife
509 N. 40th Avenue #8
Phoenix, AZ. 85009
(602) 278-2751

NEWS & NOTES

STANDARD COMMON AND CURRENT SCIENTIFIC NAMES

FOR NORTH AMERICAN AMPHIBIANS AND REPTILES

(Second Edition)

By Joseph T. Collins, Roger Conant, James E. Huheey, James L. Knight, Eric M. Rundquist and Hobart M. Smith

Available in summer 1982. The first edition of this reference, issued in 1978 as SSAR Herpetological Circular No. 7, quickly became a standard reference for herpetologists, biologists, zoos, museums, conservation organizations, wildlife societies, book publishers, and Federal and state wildlife agencies. This second, revised edition is an up-date listing over 1300 common and scientific names for species and subspecies of North American (north of Mexico) salamanders, frogs and toads, crocodilians, turtles, lizards, and snakes. New features in this edition (not in the 1978 version) are an appendix of Hawaiian amphibians and reptiles, the inclusion of the names of describers for all genera, species and subspecies, and the addition of a table comparing the number of currently recognized subspecies with those listed in earlier publications. The SSAR Committee on Common and Scientific Names (shown above) considered over 50 proposed changes for this edition, the majority of which were adopted.

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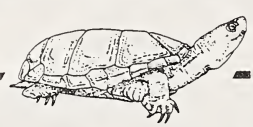


SEND ORDERS TO:

DR. DOUGLAS H. TAYLOR, DEPARTMENT OF ZOOLOGY, MIAMI UNIVERSITY, OXFORD, OHIO 45056 USA. Make checks payable to "SSAR;" receipt on request. A pricelist of other Society publications can be obtained on request from Dr. Taylor, including the Journal of Herpetology, Herpetological Review, Contributions to Herpetology, other Herpetological Circulars, Catalogue of American Amphibians and Reptiles, and the Facsimile Reprints in Herpetology series.

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

* Herpetological Circulars are no longer distributed free to SSAR members; individuals desiring copies of this and future numbers should place their orders as per the above instructions.

NEWS & NOTES

MUSEUM OF NATURAL HISTORY

The University of Kansas

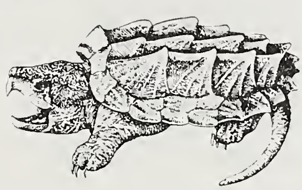
ANNOUNCES

Amphibians and Reptiles in Kansas

Second (Revised) Edition

By Joseph T. Collins

To be issued in early spring 1982, this softbound volume is a thorough update of the 1974 edition, with new sections on alien species, introductions to the main groups, endangered species, an extensive and fully illustrated technical key, and an updated bibliography to the Kansas herpetofauna. In addition, the range maps have been enhanced by the addition of over 525 new county records obtained since 1974, and most of the 150 black and white photographs are new.



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NEWS & NOTES

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NEWS & NOTES

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(206) 625-5403

FRANK L. SLAVENS
P. O. BOX 30744
SEATTLE, WA. 98103

December 17, 1981

INFORMATION REQUEST:

Dear Colleagues:

The 1982 Inventory of Live Reptiles and Amphibians in North American Collections is in the final planning stages. If you maintain a collection of live reptiles and/or amphibians please respond with the following information current as of January 1, 1982:

(1) A complete inventory of your herpetological collection. Include numbers of male/female/unknown sex for each species.

(2) A complete list of all species which were bred in your collection during 1981.

(3) A complete list of all species which have bred in your collection over the years which you feel to be significant. Put emphasis on first breedings in captivity and rare or difficult-to-breed species. If this information was listed in an earlier inventory it need not be listed again.

If your new inventory will not be completed and in by March 1st please update last year's inventory with pencil and mail it as soon as possible. Information cannot be included after the final deadline of March 1, 1982.

1981 Inventory is still available:

The 1981 Inventory contains approximately 200 pages of information compiled from 160 (70 public and 90 private) reptile and amphibian collections. It is available in paper cover \$ 15.50 (includes \$ .50 handling) or hardcover \$ 22.50 (includes \$ 1.00 handling). Order from:

Frank L. Slavens
P.O.Box 30744
Seattle, Washington
98103

PLEASE SHOW THIS NOTICE TO ALL PERSONS KEEPING
LIVE REPTILES AND AMPHIBIANS IN CAPTIVITY

News from: Audubon
NATIONAL AUDUBON SOCIETY 950 Third Avenue, New York, N. Y. 10022

For Further Information:
Mike Cohen, 212-546-9126

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SCHOLARSHIPS ANNOUNCED BY THE NATIONAL AUDUBON SOCIETY

A scholarship program for high school, college and graduate school students has been announced by the National Audubon Society Expedition Institute. The 1982 scholarships are designed to defray a student's expenses while attending school, or for a project or summer program of the student's choice. Application forms and instructions are available until August 15, 1982 by sending a self addressed stamped #10 envelope to: Scholarship Committee, National Audubon Society Expedition Institute, RFD #1, Box 149B, Lubec, Maine 04652. The financial aid and multiple scholarship grants, ranging in amounts from $100 to $200 are made available by Audubon to help young people take advantage of learning opportunities throughout the nation.

Recipient's reactions to the financial assistance has been positive. They report that the Audubon Expedition Institute scholarships have made possible the fulfillment of their immediate education and career goals such as attending schools, summer camps, workshops and travel programs, photographing endangered Alaskan wildlife, interning in conservation organizations, or participating in the Expedition Institute.

The Expedition Institute is one of many educational programs of the National Audubon Society.

NEWS & NOTES

SSAR GRANTS-IN-HERPETOLOGY

The Society for the Study of Amphibians and Reptiles is pleased to announce that proposals are now being accepted for the 1982 Grants-In-Herpetology Program. This program is designed to provide financial support to deserving individuals or organizations engaged in research on or conservation of amphibians and reptiles. Grant proposals will be considered in the following areas:

1) HERPETOLOGY-ORIENTED CONSERVATION. Proposals should address research on endangered or threatened species at the state, national or international levels, or address research on critical herpetological habitats. Proposals may be received from individuals only.

2) GRADUATE STUDENT HERPETOLOGICAL RESEARCH. Proposals may address any herpetological research endeavor and may be submitted by individual graduate students only, with a letter of support from the student's major advisor or committee chairperson.

3) REGIONAL HERPETOLOGICAL SOCIETY PROGRAMS OR PROJECTS. Proposals may address any herpetological research endeavor or project, provided said endeavor or project concerns herpetology within the implied geographic limits of the regional society. Proposals may be submitted by regional herpetological societies or by individuals. If the latter, a sponsoring letter from the current societal president or an advisor should accompany the proposal.

4) HERPETOLOGICAL RESEARCH IN ZOOS. Proposals may address any herpetological research endeavor which is conducted at a zoo. A letter from the represented zoo or supporting institution should accompany the proposal.

Each proposal should include the following information: A) Background & Objectives of the proposed project, in terms of its relevance to herpetology, B) Methods of carrying out the research or conducting the project, C) Budget for the project, according to the guidelines set forth below, and D) Letter of Support (if applicable). Proposals should be relatively brief (approx. 5 typed pages).

Budgets for the proposals should not exceed $250 in each category. The budget request should specifically relate to the project under consideration.

Successful applicants will be expected to submit to SSAR a written report of the results of their research or project, within a reasonable time after the project year is completed. They are also encouraged to submit for publication the results of their research or project, preferably to The Journal of Herpetology or Herpetological Review.

Members of the SSAR Grants-In-Herpetology Committee will evaluate all proposals, projects or programs. Committee members are: Martin J. Rosenberg (Chairperson), Terry Graham, Ralph Axtell, Lyndon Mitchell, and John Iverson.

Individuals sumbitting proposals should designate to which of the four areas their proposal applies. All proposals must be typewritten and submitted in duplicate:

Martin J. Rosenberg
Department of Biology
Case Western Reserve University
Cleveland, Ohio 44106

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Society Publications

Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are $2.00 each, unless otherwise noted.

The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at $.05/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8½ x 11 inch paper, with adequate margins. Submit original and first carbon, retaining the second carbon. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016. Price is $6.00.

Reprints are available at $.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

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BIOGEOGRAPHY OF TOBAGO, WEST INDIES, WITH SPECIAL REFERENCE TO AMPHIBIANS AND REPTILES: A REVIEW

Jerry D. Hardy, Jr.

MdHS........A FOUNDER MEMBER OF THE
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BIOGEOGRAPHY OF TOBAGO, WEST INDIES, WITH SPECIAL REFERENCE TO AMPHIBIANS AND REPTILES: A REVIEW

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INTRODUCTION

> "Perhaps now the time is ripe for an upsurge of interest in Tobago's natural history, as distinct from that of Trinidad . . . [This] should certainly be of great interest to students of biogeography. Lying as it does on the edge of the Continental Shelf of South America, [Tobago] is the last outpost of the Andean chain (according to some views), separated by very deep water and many miles from the Lesser Antilles. It is commonplace to observe that its flora and fauna are essentially continental rather than Antillean. And yet they differ markedly from those of Trinidad, providing a beautiful subject for study."
> (Trinidad and Tobago Field Naturalists' Club, 1975)

Until recently the island of Tobago has, indeed, been largely ignored by botanists, zoologists, and biogeographers. I first visited Tobago in 1964, and have since returned approximately twenty times, once for a period of seven months. During my first few visits, Tobago seemed nothing more than a relaxing miniature of Trinidad. Then one day a frog which ought to have said "bit-it" said "peep" instead, and I simultaneously realized two things: The *Colostethus* of Tobago was not conspecific with *Colostethus trinitatis* of Trinidad, and Tobago was a far more interesting place than I had previously supposed. The *Colostethus* of Tobago turned out to be closely similar or identical to a frog known only from the vicinity of Caracas and westward along the north coast of Venezuela. Since that day, too many years ago to remember well, my associates and I have discovered several other amphibians and reptiles on Tobago with apparently similar or closely-similar distributions. This, then, was the beginning of my interest in the biogeography of Tobago.

I am persuaded that the science of biogeography, properly pursued, should be approached as a multi-discipline study. The puzzling biogeography of Tobago, for example, will not be understood on the basis of a single collection of snakes, a single collection of birds, a single collection of fishes, or, for that matter, a single collection of vertebrate fossils. For this reason, and in spite of the fact that my

Figure 1. Geographic location of Tobago, West Indies, in relation to other islands of the Caribbean and the coast of Venezuela.

principal interest in Tobago was initially herpetology, I began, several years ago, to accumulate books and papers on all aspects of the botany, zoology, and geology of Tobago. From this collection, which now numbers over 2000 titles, I have been able to document a broad base of biogeographical information, some of which contradicts my findings in herpetology.

The present paper, then, is intended to summarize my work with amphibians, reptiles, and (to a lesser extent) mammals of Tobago, and to review, briefly, what is known of other major groups and their biogeography on the island. It is a paper primarily intended to present problems, and is pointedly designed to suggest few if any answers to those problems. Years will probably pass before the biogeographical significance of Tobago is realistically appraised and understood.

Figure 2. Principal physiographic features of Tobago.

Figure 3. Drainage pattern of Tobago. Note that the river resources outline the summit of the Main Ridge.

THE STUDY AREA

General Description

Tobago lies near the southeastern corner of the Caribbean Sea (Fig. 1). It is an elongate, more or less elliptically-shaped island approximately 26 miles long and 7.5 miles wide. Its major axis is inclined about 30° North, and its total area is generally estimated to be 114 square miles. It lies precisely on the edge of the Continental Shelf, and, in that sense, forms the extreme northeastern corner of the South American Continent. Trinidad, Tobago's nearest neighbor, is 22 miles away and is visible from the southern end of Tobago on a compass heading of approximately 195°. The lush, green continent of South American lies just over the south-western horizon a few miles beyond Trinidad. Tobago's next nearest neighbors are the Lesser Antillean Islands of Grenada (about 80 miles at a heading of approximately 315°), the Grenadines, St. Vincent (about 128 miles at a heading of approximately 315°), and Barbados (about 130 miles at a heading of approximately 28°).

The most visible physiographic feature of Tobago is the Main Ridge (Fig. 2). This ridge, approximately fifteen miles long, terminates abruptly in the vicinity of Charlotteville at the north end of the island. Although several authors have indicated maximum elevations of 1890 to 2000 feet, the actual maximum elevations appear to be 1856 feet (at a point approximately mid-way along the length of the Main Ridge) and 1804 feet at Pigeon Peak (a discrete, clearly-defined mountain near Charlotteville). The mountains of Tobago are characterized by steeply broken ridges and gullies, particularly along the northeastern coast.

In the southern end of the island, the dominant physiographic feature is a broad coastal platform consisting primarily of ancient coral rock. This coral platform, which covers an area of approximately 30 square miles, reaches a maximum elevation of approximately 25 feet. Several small, geologically distinct, low hills thrust through this platform.

The mountains are drained by a number of steeply flowing rivers (Fig. 3). Some of these drop almost precipitously into the sea, while others cross narrow coastal areas characterized by tidal marshes. Many of the smaller rivers of the Main Ridge are seasonally dry or essentially so. The rivers of the southern lowlands are typically short and slow-moving and generally flow into marshy areas. There are two well-developed marshes in southern Tobago: Kilgwyn Swamp and Bon Accord Lagoon. Unfortunately, many of the coastal marshes and swamps of Tobago have been destroyed or damaged through intentional drainage or the long-term effects of siltation.

The coast of Tobago is indented by a number of deep bays, most of which contain extensive coral growths. A major coral reef (Buccoo) is

developed at the southern end of the island just off Bon Accord Lagoon.

There are a number of small islands off Tobago, especially in the north. The largest of these, little Tobago (Bird of Paradise or Ingram Island) and St. Giles (Melville Island), reach maximum elevations of 460 and 350 feet respectively (Beard, 1944; Dinsmore, 1970c; Dinsmore and ffrench, 1969; ffrench, 1976; Niddrie, 1980; Underwood, 1962; personal observations).

Geology

There have been few papers which have dealt significantly, in whole or in part, with the geology or geological history of Tobago (Cunningham-Craig, 1907; Girard and Maury, 1980; Hardy, et al, 1931; Marshall, 1981; Mattson, 1977; Maxwell, 1948; MacGillavry, 1977; Rowley, 1979; Rowley and Roobol, 1978; Trechmann, 1934; Weyl, 1966). Maxwell recognized eight geological formations in Tobago, six of which were assumed to be of Cretaceous age. These six were divided into two subgroups, the North Coast Schist Group, and the Tobago Volcanic Group, wach of which contained three formations (Maxwell, 1948). The oldest rocks on the island are probably fault enplaced slivers of ultramafics found within the metamorphics of the Main Ridge Formation (a part of Maxwell's North Coast Schist Group). These may be of Jurassic age (Rowley and Roobol, 1978). The Rockly Bay Formation, in the southern part of the island, consists of fossiliferous clays, sands, marls, and conglomerates. Maxwell judged this formation to be of Pliocene and upper Miocene age (Maxwell, 1948), while Rowley (1979) judged the age to be "upper Lower-lower Middle Pliocene". The youngest geological formation on the island formed during the Quatenary Period and consists of coral limestone deposits in the southern part of the island (Maxwell, 1948).

Tertiary and Quatenary fossil deposits occur in south Tobago. Until recently, these deposits were known to contain only invertebrate fossils (Guppy, 1921a, 1921b; Trechmann, 1934). In 1979 vertebrate fossils were discovered in the Tertiary coral limestone deposits at Cursoe's Cave (present research).

Maxwell felt that, except for flooding at its margins, Tobago has probably been a land area since late Cretaceous times. Partial submergence may have occurred during the Eocene, during the late Miocene and early Pliocene, and one or more times during the Quatenary. Prominent sea cliffs and an enbayed shoreline indicate recent relative submergence.

Koldewijn (1958) points out that recent tectonic dislocations are likely in the area of Trinidad and Tobago, and that several indications of such dislocations can be found on Tobago. Earthquakers are apparently rare in or near the island: only one was recorded between 1950 and 1964 (Meyerhoff and Meyerhoff, 1972; Molnar and Sykes, 1969; Nagle, 1971; Sykes and Ewing, 1965).

Although Donnelly and Rogers (1978) and MacGillavry (1977) suggest a possible relationship between igneous rocks in Tobago and certain islands of both the Lesser and Greater Antilles, Girard and Maury (1980) find that cretaceous spilites of Tobago belong to the island arc of northern Venezuela, and conclude that the lava types of Tobago suggest an active margin related to a zone of seduction, and are not related to the basaltic lavas typical of the oceanic crust.

Stephen, et al (1980) note that Tobago, in fact, is, as has long been supposed, a part of the Caribbean Mountain Chain which begins at Santa Marta, Colombia. They point out that the physical events upon which this chain developed date back to the Jurassic or Early Cretaceous period. Further, Meyerhoff and Meyerhoff (1972) consider the Barbados Ridge to be a continuation of the North Venezuela-Trinidad fold belt that projects north-northeastward from Trinidad and Tobago. The entire area from Trinidad to Barbados, including Tobago, therefore "belongs structurally and stratigraphically to northern South America and the Venezuelan Netherlands Antilles". Underwood (1962) expresses the view that "Tobago was thrown up from the sea bed independently of the formation of the Northern Range of Trinidad".

In spite of all that is known about the geology of Tobago, its assumed geological history, and its assumed relationship to the Caribbean Mountain Chain, three vexing questions remain, the answer to any one of which would be of enormous value to students of Tobagonian biogeography:

1) Has Tobago always been in the same position it now occupies relative to Trinidad and the South American Continent?

2) On what tectonic plate is Tobago?

3) Was there ever a dry-land connection between Tobago and Trinidad and/or the South American mainland?

In any attempt to resolve these questions, one is immediately confronted with a vast array of facts, opinions, theories, and countertheories involving the origin and development of the entire Caribbean. General papers dealing with this broad concept which were found to be most useful in the present study include Barr (1974), Bernoulli and Lemoine (1980), Carey (1958), Chase and Bunce (1969), Dickenson and Coney (1980), Feo-Codecido (1973), Malfait and Dinklemann (1972), MacGillavry (1970), Mattson (1977), Meyerhoff and Meyerhoff (1972), Mooney (1980), Nagle (1971), Oxburgh (1966), Salvadore and Green (1980), and Weyl (1964). From all of this there emerges the story, here told very briefly, of the breaking apart of the continents of North America, South America, and Africa; and the consequent development of the "Caribbean Plate" and its eastward movement relative to the present position of North and South America. The Caribbean Plate is now being underthrust by the Atlantic Plate along its eastern margin.

The southern margin of the Caribbean Plate has been the subject of some fascinating recent speculation. It is intriguing, for example, to note that Nagle (1971) and Carey (1958) show the precursors of the "Lesser Antilles" far west of the present position of Trinidad, and, in fact, far west of the Unare Gap of Venezuela during the early Mesozoic.

Salvador and Green (1980) indicate that a narrow wedge of the Caribbean Plate had moved eastward to a position approximately north of the present position of Trinidad by Campanian times (Late Cretaceous); while Oxburgh (1966) shows the coast of South America far south of its present position and a rising elongate land mass north of this ancient coast line during the same time. During the Cenomanion time, this land mass was above water, forming an elongate island which probably extended eastward to the position presently occupied by Tobago.

Saunders (1980) pointed out that the Scotland Formation of Barbados, consisting of sandstones, mudstones, and conglomerates, could only have been formed by a major river drainage system. The source of this material may have been an ancient river flowing through the Unare Gap, a conspicuous break in the Coastal Range of Venezuela. The Scotland Formation of Barbados, enplacement of which may have taken place during the Eocene, may therefore have originated about 500 km west of its present position.

The El Pilar Fault passes along the northern coast of Venezuela, enters the sea at or slightly south of the Paria Peninsula, passes through Trinidad in the vicinity of the Northern Range, and continues eastward south of Tobago (Barr, 1958). It has obviously played an important role in the geological development of both Trinidad and Tobago. Malfait and Dinklemann (1972) note that large displacements took place along the El Pilar Fault, and that these major movements continued into the late Miocene. Nagle (1971) suggested that "several of the larger faults" (presumably including the El Pilar Fault) "have different movements along different parts of the same fault line and/or that their present relative movement is different from past relative movement". Finally, Case (1975) hypothesized that the El Pilar Fault is not a single fault, but rather a complex zone of "multiple parallel traces".

While it is thus evident that a great deal of geological activity has taken place along the southern edge of the Caribbean Plate, there is, unfortunately, not one shred of evidence to indicate whether or not Tobago has maintained its same position relative to Trinidad or South America throughout its history. It would be surprising, however, if it has.

There is also no clear evidence to indicate which tectonic plate Tobago is on. Some early workers felt that the South Caribbean Fault which passes between Grenada and Tobago (Martin-Kaye, 1977 (1969); Barr, 1958) marked the southern edge of the Caribbean Plate; but

Meyerhoff and Meyerhoff (1972) presented evidence to show that this was untenable. Their small map, reproduced from Morgan (1968) shows the southern edge of the Caribbean Plate on the Venezuelan mainland south of the latitude of Trinidad. Malfait and Dinklemann (1972) note that, in Venezuela, the southern boundary of the Caribbean Plate lies between the Dutch Leeward Islands and the Guiana Shield. Their map of the present location of the Caribbean Plate would barely include Tobago. More recent maps (Uchupi, 1975; Ladd, 1980) show the leading edge of the Caribbean Plate far south-east of Tobago, but do not connect the plates in the vicinity of Trinidad and Tobago (although one is left with the impression that Tobago is, indeed, on the Caribbean Plate). Finally, Rowley and Roobol (1978) make the intriguing statement that "Tobago is situated *at* (italics are mine) the southeastern corner of the Caribbean Plate".

As early as 1813, Dauxion Lavaysse alluded to the probability of a dry-land connection between Trinidad and Tobago (Dauxion Lavaysse, 1913a). Boettger (1895) concluded that it was "very likely" that Tobago "was in former times joined to Trinidad". ffrench (1976) speculated that Tobago separated from South America much earlier than Trinidad. Estimates as to when the hypothetical Tobago land bridge last existed vary from 10,000 years (Faaborg, 1977) to 500,000 years (Beard, 1944).

Both Underwood (1962) and Koldewijn (1958) have speculated on the relationship of Tobago to Trinidad in recent geological times. Underwood studied depth data from British Admiralty charts. Although he was unable to accurately determine the depth of certain parts of the passage between Trinidad and Tobago, he concluded that it would "seem likely that Tobago was joined to Trinidad by low-lying land during the last ice age". Bottom samples studied by Koldewijn indicated several ancient terrestrial, fluviatile, and fluviomarine environments east of Trinidad, and an ancient coral reef north of the Paria Peninsula (Fig. 4). Wood fragments from Station 1109 were estimated to be 17,820 ± 600 years old. From this study, he concluded that much of the area east of Trinidad was formerly dry land. Assuming a minimum sea level lowering of 70 meters and a possible maximum of 100 meters, he concluded that during the last glacial period "there was probably a narrow channel between Trinidad and Tobago" and "in part of the sandy region east of Tobago, very shallow marine conditions probably prevailed shortly after the maximum of the last glaciation". Ten thousand years ago "the sea had risen to within 100 feet of its present level and . . . the channel between Trinidad and Tobago was already rather wide".

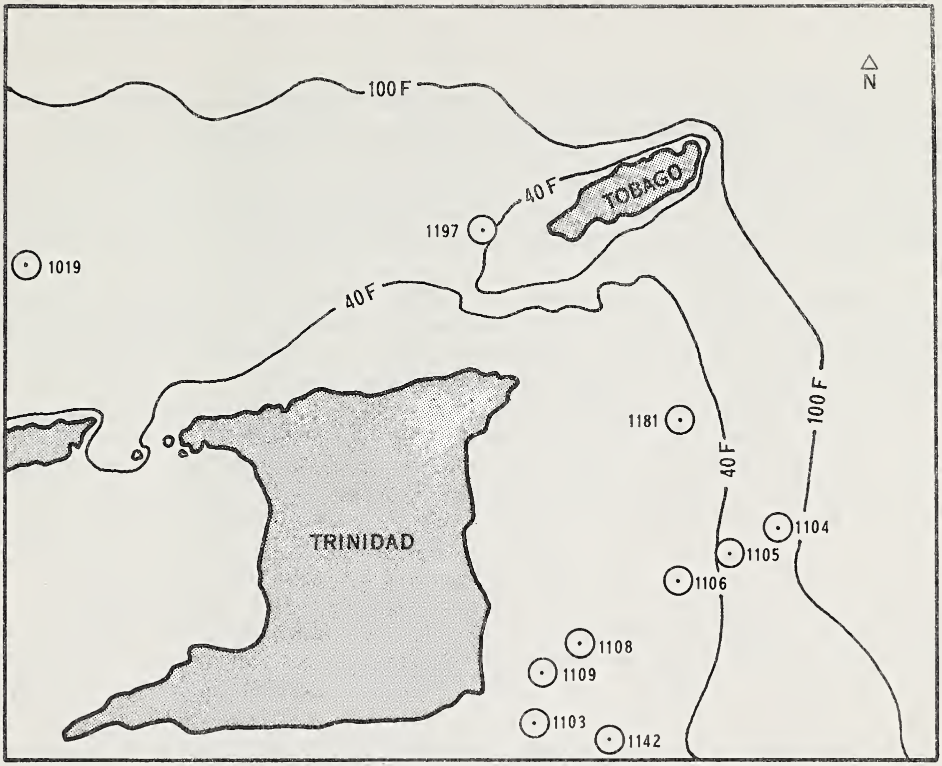


Figure 4. Possible nature of coastal areas east and north of Trinidad during the last glacial period as indicated by analysis of bottom samples. Station 1109 (24 fathoms), probably terrestrial. Station 1181, possibly terrestrial. Station 1108, fluviatile or fluviomarine. Stations 1103 (27 fathoms), 1104 (96 fathoms, with pollen), 1105, 1106, 1142 (33 fathoms), probably fluviomarine (indicating rivers or river mouths far east of the present coast line). Station 1197 (34 fathoms), very shallow water. Station 1019, ancient coral reef, probably very near ancient shore line. The 40 fathom (73.2 meter) contour is indicated. Minimum sea level lowering is estimated to have been 70 meters, maximum possibly 100 meters. (Map modified from Koldewijn, 1958).

The actual depth of the sea bottom around Tobago at the present time is hard to assess in view of the immense sediment build-up in the area. Saunders (1980) has pointed out that since the Miocene, the Orinoco River has deposited an enormous amount of sediment off Venezuela and southeast of Trinidad. Tobago is clearly influenced by the Orinoco Current, and the sea around Tobago is subject to siltation from the Orinoco (Aragno, 1971; Gade, 1961; Guilcher, 1963).

It is interesting to speculate that when Tobago became a permanent land mass during the Cretaceous, the coast of Africa was, figuratively speaking, just over the eastern horizon. Surely depths, silt deposits, and currents around Tobago were quite different at that time than they are today.

Climate

The earliest meteorological data for Tobago was recorded in 1889 (Hart, 1890). Subsequently rainfall records were published in the Bulletin of the Department of Agriculture of Trinidad and Tobago beginning in 1910, and in the Proceedings of the Agricultural Society of Trinidad and Tobago beginning in 1922. Adequate meteorological data for Tobago has not been available, however, until relatively recent times.

Beard (1944) felt that "climatically Tobago belongs to the Lesser Antilles", and that, overall, the climate of Tobago is "slightly different" from that of Trinidad. Maximum rainfall, for example, falls in November in Tobago and in August over most of Trinidad. Average rainfall varies greatly from year to year and from place to place on the island. Data taken over a period of 31 years, for example, shows an overall average of 56.19 inches of rainfall in the southwest (Government Farm) and 93.08 inches in the northeast (Hermitage), and a dry/wet year variation of 31.42 to 130.64 inches in the southwest and 68.62 to 135.56 in the northeast. Beriidge (1981) shows maximum rainfall in the vicinity of the high point of the Main Ridge and minimum rainfall in the vicinity of the southern lowlands. In Tobago the dry season usually extends from January to May and the wet season from June to December (Beard, 1944), although, as Niddrie (1980) has pointed out, this can be highly variable. He notes also that a "petit Careme" (a period of relatively dryness) usually occurs in July, August, or September, and lasts about three weeks. Although Tobago is generally considered to be outside the "hurricane belt", Niddrie lists nine storms of or close to hurricane intensity which have been recorded since 1821:

(month unknown)	1821	October	1891
June	1831	August	1918
October	1847	August	1928
September	1878	September	1963
September	1889		

Only two of these storms, the one in October, 1847, and Hurricane Flora in 1963, were severe. Hurricane Flora damaged much of the rain forest of the Main Ridge (Niddrie, 1980) and apparently had the effect of causing an increase in populations of certain birds, while causing a marked decrease in population of others (ffrench, 1976).

The northeastern trade winds blow constantly in Tobago, and are a significant component of the climate of the island (Beard, 1944).

PLANTS

Excellent botanical collections, apparently still available at Kew Gardens, were made in Tobago during the latter part of the nineteenth century by Baron Heinrich von Eggers, and between 1908 and 1933 by Mr. W. E. Broadway. Subsequently numerous collectors have worked in Tobago. It is surprising, therefore, that few papers have appeared which deal exclusively with the higher plants of Tobago. Among these, however, are the excellent works of Beard (1944), Broadway (1916, 1918), Gregson (1968), and Sandwith (1938). Records of plants of Tobago are also available in various issues of the series *Flora of Trinidad and Tobago* which was begun in 1928 in Trinidad where it is still being published; and in Ignatius Urban's descriptive volumes on the flora of the Antilles (Urban, 1900-1928). Schultes (1960) gave many records of Tobago orchids in his study of the orchids of Trinidad and Tobago.

Beard (1944) recognized four plant communities in Tobago, one of which, the Rain Forest Community, is divided into three distinct forest types.

The Mangrove Woodland Community is characteristic of areas which are subject to the tides and are, consequently, inundated by brackish water. These marshes are regarded as ecologically similar to mangrove marshes found throughout the Caribbean.

The Littoral Woodland Association includes sea shore vegetation, among which characteristic trees are sea grape (*Coccoloba* sp.) and manchinell (*Hippomane mancinella*). The Littoral Woodland Association typically occurs in well-watered areas and contains luxuriant vegetation. The plants, however, are frequently dwarfed and windswept.

The Deciduous Forest Association formerly covered most of the lower elevations of Tobago, but was largely destroyed through land clearing. The vegetation on Little Tobago Island is described as typical Deciduous Forest Association, and is, in fact, the only extensive example of this association remaining in Tobago. Typical trees of the Deciduous Forest Association include naked boy, *Bursera simaruba*; dogroot, *Lonchocarpus domingensis;* and silver thatch palm, *Coccothrinax barbasensis*. Lianas are rare, and the trees in this association typically do not develop buttresses.

The Rain Forest Association covers the entire Main Ridge. The Lowland Rain Forest Type is typically found below 800 feet, but may reach elevations of 1200 feet. A closed canopy is found at about 120 feet, and the larger trees are buttressed. The Lower Montane Rain Forest Type occurs from 800 feet to the summit, but only on soils derived from schist. This is the typical rosewood-redwood forest of Tobago (*Byrsonima spicata* and *Ternstroemia oligostemon*). There are two strata, and the upper canopy is low as a result of exposure to wind. Buttressing is virtually absent, and trees with simple leaves are

predominant. The Xerophytic Rain Forest Type also extends from 800 feet to the summit, but only one soil derived from igneous rock. Typical plants are gooseberry, *Manilkara bidentata*, and blue copper, *Guettarda scabra*. This forest type usually occurs in well-drained areas which are exposed to the wind. There is a more or less continuous canopy at 40 to 60 feet, but some trees up to 90 feet tall break through the canopy. Lianas are rare and epiphytes are scarce. Razor grass (*Scleria*) is abundant in the windward gaps.

Extremely xeric conditions occur on some of the offshore islands. Dinsmore and ffrench (1969) describe St. Giles Island as covered with "thick masses of cactus, low brush, and trees, some as tall as 30 feet". They note that there is no permanent source of fresh water.

Beard (1944) concluded that the forests of Tobago were comprised of trees primarily of South American origin. He noted, however, that the floral associations of Tobago had a "curiously Antillean stamp", and attributed this to the fact that the climate of Tobago is more Antillean than Trinidadian. Only two trees, neither of which are found in Trinidad, were of Antillean origin, and there were at least eight endemic trees on the island. Most significantly, he listed six South American trees which were found on Tobago, but were "absent or exceedingly rare" on Trinidad:

Amomis caryophyllata	*Eschweilera decolorans*
Conomorpha peruviana	*simaruba amara*
Chione venosa	*Guettarda scabra.*

Sandwith (1938) pointed out that there were a number of endemic plants on Tobago; that among the dry thickets of the coastal slopes of southern Tobago there were plants that were widely distributed in the Antilles and the islands along the coast of Venezuela, but were rare or absent in Trinidad; and that one plant, *Maxillaria liparophylla* was found only on Tobago and in Guyana, while another, *Dichromena ciliata*, was found only on Tobago and Margarita.

Agricultural and horticultural interests have caused enormous ecological changes in the flora of Tobago, especially at lower elevations. So many plants have been introduced into Tobago that it is sometimes difficult to recognize the indigenous flora. Through the years major crops have included sugar, cotton, indigo, rubber, and cocoa; and extensive pasture lands have been developed, sometimes at surprising elevations (personal observations). Associated with all of this has been a great parade of domestic animals, including even, at one time, camels (West India Committee, 1933).

Beard (1944), who assumed that a land bridge to Tobago had existed no later than 500,000 years ago, concluded that the dispersal of plants to Tobago took place during the Eocene or Oligocene.

INVERTEBRATES

There are an enormous number of published records of various terrestrial and fresh water invertebrates found in Tobago. Unfortunately most of these are scattered through the pages of major taxonomic reviews or broad-based geographic studies, and are consequently difficult to recover. Butterflies and fresh-water shrimp are the best-known groups on the island: Hart (1980) presented and excellent review of the shrimp; and there have been, over the years, a number of papers dealing exclusively with butterflies (Barcant, 1982; Longstaff 1908, 1912; Sheldon, 1936). Additionally there have been a number of important papers dealing with various components of the invertebrate fauna of both Trinidad and Tobago. Examples are Barcant's study of butterflies of the two islands and Hinton's review of *elmid* beetles (Barcant, 1970; Hinton, 1971).

There is, on Tobago, a high degree of endemism among the invertebrates. Park et al (1976), for example, named seven new pselaphis beetles, all apparent endemics, from the island. Chamberlain (1918) and Loomis (1934) named a number of new, apparently endemic, myriapods (millepeds and centipeds) from the Tobago, and recent collections by my colleagues and I indicate the presence of other un-named species on the island. Kjellesvig-Waering (1966) described a new, apparently endemic, scorpion, *Proteochactas laui*. There are many more examples of endemic invertebrates on Tobago, especially among the insects; and I have never returned from Tobago with a collection of insects which did not contain at least one undescribed (and presumably endemic) species.

There are also a number of endemic subspecies. Pilsbry (1895-6), for example, regarded the Tobago population of the land snail *Bulimus oblongus* as a distinct subspecies, calling it *Bulimus o. tobagoensis*. As recently as 1982, Barcant described two very distinct subspecies of butterflies of the genus *Heliconius* from the island (Barcant, 1982). Clark (1915) regarded the Tobago peripitus as a distinct, endemic subspecies, *Epiperipatus trinidadensis broadwayi*.

The occurrence on Tobago of a high level of both specific and subspecific endemism suggests long geographic isolation.

The Tobago insect fauna is primarily of South American origin, and there has been an obvious dispersal of South American forms northward through the Caribbean (Marcuzzi, 1962; Brown, 1978; Brindle, 1971; Scott, 1972; Hinton, 1971). On the other hand some West Indian insects, such as the beetle, *Aphodius cuniculus*, reach the southern limit of their distribution at Tobago (Cartwright and Chalumeau, 1978).

Chace and Hobbs (1969) list two fresh-water decapods which occur in Tobago and are otherwise endemic to the Antilles (*Macrobrachium faustinum* and *Uca burgersi*). They assume that the ancestral stock of *M. faustinum* reached the greater Antilles from the Central American-

Mexican region, and that there was a subsequent dispersal southward, down the Antilles, toward Tobago. *Uca*, on the other hand, could be of South American origin, although clear evidence is lacking. Hart (1980) reported the occurrence of the fresh-water shrimp, *Jonga serrei*, on Tobago. Although Chase and Hobbs (1969) surmised that *Jonga* like *Macrobrachium*, had dispersed from the Central American-Mexican region, Hart (1980) suggested that the occurrence of *Jonga* on Tobago may indicate a southern dispersal route.

In spite of numerous records and dozens of published papers, the biogeography of the invertebrate fauna of Tobago remains poorly known. Among the broad, diverse fauna, however, will probably be found a stronger Caribbean element than has been documented for any of the vertebrate groups.

FISHES

Guppy (1910), in a paper dealing with the fresh-water fishes of both Trinidad and Tobago, listed two species from Tobago. About twenty-six years later, in an unfortunately unpublished manuscript (now preserved in the West India Collection, Central Library, University of the West Indies, Trinidad), he listed both marine and fresh-water fishes from both islands (Guppy, ca 1936). This list, although primarily concerned with Trinidad, added numerous species to the Tobagonian ichthyofauna. Norman (1922, 1925) mentioned that Guppy had collected 150 species on Tobago, and described two of these as new. Price (1955) presented an annotated list of the fresh-water fishes of both Trinidad and Tobago; while Caldwell and Caldwell (1964) listed 33 marine species. Craig (1968) mentioned 20 coral reef fishes known to occur commonly on Bucco Reef. Later, Kenny (1976) listed 54 species from the same reef. Ramsaroop (1982) listed 89 species from Man-O-War Bay. Hubert E. Wood, Chief Fisheries Officer of Trinidad and Tobago, has allowed me to examine his unpublished list of the fishes of the Buccoo Reef-Bon Accord Lagoon region. This list contains 97 species. From these lists, an exhaustive literature search, and their own recent collection, Hardy, et al (1982) recorded a tentative total of 355 marine and fresh-water fishes from Tobago.

From all of this, several patterns emerge. The marine fish fauna of Tobago is considerably different from the marine fish fauna of Trinidad. This difference reflects the abundance of coral reefs around Tobago, and the decreased influence of the Orinoco River. Tobago has a typically West Indian inshore fish fauna, while the inshore fish fauna of Trinidad is typically continental. There are also differences in pelagic fishes between the two islands. Collette and Russo (1978) and Collette, et al (1978) show, for example, that the Spanish mackerel, *Scomberomorus brasiliensis*, occurs around Trinidad. Our records show that the Spanish mackerel of Tobago is *Scomberomorus regalis*. One of the most interesting features of the marine fish fauna of Tobago is the

fact that two species of venomous toadfishes occur there (*Thalassophryne maculosa* and *T. nattereri*). These species, collectively, occur along the coast of South America, around Trinidad, and the Venezuelan Islands, but do not enter the Lesser Antilles (Collette, 1966).

Tobago has a depauperate fresh-water fish fauna which consists primarily of mountain mullet, several livebearers and gobies, one killifish, and one swamp eel. Although Price (1955) recorded a fresh-water cat fish (*Haemomaster venezuelae*) from Tobago, he has since informed me that this record is based on a mis-identification. A large fresh-water cat fish, *Hypostomus robinii*, does occur in Tobago. Although this fish may have been introduced, Tobago specimens seem different in several characters from Trinidadian *H. robinii sensu* Boeseman (1960). If the population of this fish on Tobago is of natural occurrence, it would certainly tend to support the concept of an ancient land bridge to Tobago.

BIRDS

The bird fauna of Tobago is extremely well-documented. Since 1846 no less than ten authors have presented lists of birds occuring throughout the island (Jardine 1846, 1847a, 1847b, 1847c; Kirk, 1883, 1899; Cory, 1893; Dalmas, 1900; Eastman and Eastman, 1957; Alford, 1958; Edey, 1960; Kleinwort, 1967; and Bond, 1970); while Dinsmore (1972), Dinsmore and ffrench (1969), Morris (1967, 1977), and Spaans (1973b) presented excellent accounts of the native birds of St. Giles Island and Little Tobago. Additionally, Brackenridge (1971), Collins (1969), ffrench (1975, 1977), ffrench and ffrench (1966), and Spaans (1973a) contributed important distributional data, while Bond (1962) discussed a number of questionable records from the island. Excellent species accounts are also available in the writings of several authors who have dealt with the avifauna of both Trinidad and Tobago (Belcher and Smooker, 1934, 1935, 1936a, 1936b, 1973a, 1937b; ffrench, 1976; Fielden, 1914; Herklots, 1957; and Junge and Mees, 1961).

A number of important introductions have occured on Tobago. The cattle egret, *Bubulcus ibis*, reached Tobago adventitiously in 1960 and is now found throughout the island. According to ffrench (1976), the saffron finch, *Sicalis flaveola*, was introduced in Tobago in 1958, while the lesser seed-finch, recently seen on the island, may have been similarly introduced. Niddrie (1980) records the recent introduction of the great kiskadee, *Pitangus sulphuratus*, and Charles Turpin (personal communication) informs me that blue-and-yellow macaws, *Ara ararauna*, which he released at Charlotteville within the past ten years have successfully bred in the forests of the Main Ridge. Aside from the well-known introduction of the Bird of Paradise (*Paradisaea apoda)* on Little Tobago Island (Baker, 1922, 1923; Dinsmore, 1969, 1970a, 1970b; Gilliard, 1958, 1959; Guppy, 1931; Hamilton, 1917; Herold, 1911;

Ingram, C., 1913; and Ingram, W., 1911, 1913, 1917), two other exotic species, the "Chinese pheasant" (presumably *Phasianus colchicus*) and the jungle or domestic fowl, *Gallus gallus*, have been introduced on Tobago (Bond, 1972; Dinsmore, 1970b; Niddrie, 1980).

ffrench (1976), in combining resident and non-resident species, questionable records, and introductions then known to him, recorded a total of 181 birds from Tobago and 400 from Trinidad. He alludes to, but does not specifically identify, species which have historically been recorded from Tobago but may now be extinct. He noted a reduction in the numbers of at least four species following Hurricane Flora in 1963, and pointed out that one of these, the white-tailed sabrewing, *Campylopterus ensipennis*, "seems to have been almost completely extripated". Ponytz (1683, 1695) and Anonymous (ca. 1746) mention two birds from Tobago which are presumably now extinct: the "blew-headed parrot" (possibly *Pionus menstruus*) and a macaw colored with "blews, reds, and greens" (possibly *Ara manilata*).

Of the total number of birds on the islands of Trinidad and Tobago, ffrench (1976) recorded 86 resident (breeding) species from Tobago and 242 resident (breeding) species from Trinidad. Bond (1963) found a similar relationship among "land birds": 70 in Tobago and 200 in Trinidad. On Grenada, the next nearest island to Tobago, he found only 30 "land birds". In a later paper (Bond, 1979), he combined counts of Tobagonion "land birds" and birds of prey and noted that, of these, 69 were derived from the south while only 4 were of Lesser Antillean origin. Lack (1976) concluded that the avifauna of Tobago was primarily South American, while that of Grenada was West Indian, but with a strong South American element. He postulated a faunal barrier between these two islands which he termed "Bond's Line", and noted that only seven Tobagonian birds of mainland origin enter the Lesser Antilles, and then only as far as Grenada. With the exception of a population in western Mexico, the Caribbean martin, *Progne dominicensis*, is found only in the West Indies and is the only West Indian bird of which there is a breeding population in Tobago. It is not found in Trinidad (ffrench, 1976). This is the only clear evidence, in fact, of a true Caribbean influence in the Tobagonian land bird fauna.

Like Bond, Slud (1976) noted a striking difference in the avifaunas of Tobago and Grenada in spite of the fact that both are "rainforested, high islands of equal size and with similar passerine-nonpasserine ratios". He attributed the difference in the avifaunas of these two islands to the fact that "Tobago lies close to and is fed by its parent, Trinidad" while "Grenada sits apart as the terminal link in the Antillean chain".

Faaborg (1977) concluded that Trinidad and Tobago were connected during the last glacial period, or "about 10,000 years ago" and at that time had a "full mainland species quota". He suggested that, since becoming isolated by water barriers, these two islands have "relaxed

their species totals to levels more appropriate for islands of their area and isolation" (see also Terborgh, 1974). Isolation through loss of a land bridge results in what Diamond (1972) calls "land-bridge relics". As noted by Faaborg (1977), at least two such relics occur on Trinidad and Tobago: the blue-crowned motmot (*Momotus momotus*) and the rufous-tailed jacamar (*Galbula ruficauda*).

ffrench (1976) lists eleven South American birds which are represented by breeding populations on Tobago, but do not occur on the island of Trinidad:

Rufous-vented chachalaca	*Ortalis ruficauda*
Striped owl	*Asio clamator oberi*
Red-crowned woodpecker	*Melanerpes rubricapillus terricolor*
Olivaceous woodcreeper	*Sittasomus griseicapillus*
White-fringed antwren	*Formicivora grisea tobagensis*
Blue-backed manikin	*Chiroxiphia pareola atlantica*
Venezuelan flycatcher	*Myiarchus venezuelansis insulicola*
Scrub greenlet	*Hylophilus flavipes insularis*
Black-faced grassquit	*Tiaris bicolor omissa*
Variable seedeater	*Sporophilia americana americana*
White-tailed sabrewing	*Campylopterus ensipennis*

All of these species can be viewed as land-bridge relics *sensu* Diamond (1972).

ffrench (1976) noted a much higher percentage of endemic subspecies among the breeding populations of Tobagonian birds than among those of Trinidadian species and pointed out that this was to be expected, since Tobago's "separation from the mainland took place so much longer ago". It is interesting to note that five of the eleven species which occur on Tobago and the mainland but not on Trinidad are represented by wholly endemic subspecies on Tobago.

With the exception of the Caribbean martin, the bird fauna of Tobago is of South American origin; there is some evidence of extinction of birds within the last four centuries; there is a high degree of subspecific endemism on the island; and there is a surprisingly high number of what are probably best regarded as land-bridge relics.

MAMMALS

Goodwin and Greenhall (1961) contrasted the mammalian fauna of Trinidad and Tobago as follows:

	Trinidad	Tobago
Terrestrial mammals	32 (5)*	12 (3)
Aquatic mammals	1	0
Bats	47	17

* ( ) introduced species

This list, presented in conjunction with a detailed review of the bats of Trinidad and Tobago, was "based largely on species collected by Franklin Thurab in 1960 for the American Museum of Natural History". For this reason, the authors elected to omit a number of kinds of mammals said to occur on Tobago by earlier authors (mostly of the seventeenth, eighteenth, and nineteenth centuries), but of which specimens were not available. This list includes:

monkey	ocelot
sloth	manatee
fox	peccary
raccoon	wild hog
musk rat	

The monkey has been mentioned only once, and then without supporting documentation (Anderson, 1956). Both Alford (1968) and Niddrie (1980) comment on the occurrence of a small sloth on Tobago, but I have found no mention of this species by earlier authors. Rochefort (1665, 1666) mentioned the occurrence of foxes ("renard") on Tobago, while Anonymous (1749) implies that these animals were hunted for their skins. The raccoon was mentioned by Woodcock (1867) and Ponytż (1683, 1695) who commented that the "racone" was similar to an English badger. The musk rat was first mentioned by Rochefort (1658, 1665, 1666) as "rats musques" (Fig. 5). Subsequently, Anonymous (1749) stated that the musk rat was very common on Tobago, lived in burrows in the ground, and had a strong scent. Dauxion Lavaysee (1813b) called the Tobago population of this animal by the French name "Piloris", and applied the name *Mus Pilorides* to a population of apparently the same animal in Venezuela (Dauxion Lavaysse, 1820). Although Allen (1911) placed *Mus pilorides* in the synonymy of *Capromys pilorides*, he none the less identified the Tobagonian musk rat as *Megalomys desmarestii*, a species which "probably once occurred throughout all or most of the Windward Islands" but is now extinct. The ocelot was referred to as "chats sauvage" by Rochefort (1665, 1666) who commented on its beautiful color and the fact that it was hunted for its fur. The same animal was mentioned as "jaguar" or "chats tigres" by Dauxion Lavaysse (1813b), "wild cat" by Anonymous (1749), "el cunaquaro, *Felis tigrina*", by Armas Chitty (1967), and

"plesīque oseloti" (in Latvian) by Anderson (1970). It is interesting to note that "chat tigre" is one of the common names of the ocelot, *Felis pardalis* in Trinidad (Goodwin and Greenhall, 1961). Both Dausion-Lavaysse (1813b, 1820) and Rochefort (1665, 1666) described the manatee under the names lamentin, lamantin, and *Trichecus Manati*. The manatee once occurred on Grenada (Groome, 1970) and may still occur in Trinidad where it is considered endangered and possibly extinct (Thelen and Faizool, 1980). It almost certainly occurred in Tobago where appropriate habitat was apparently once available (Beard, 1944). The peccary (Fig. 6) was mentioned variously as peccary, percari, quenck, javaris, paquires, and *Tayassu* by a number of authors (Allen, 1911; Anderson, 1970; Armas Chitty, 1967; Bowman and Bowman, 1939; Capadose, 1845; Collens, 1912; Dauxion Lavaysse, 1813b; Fowler, 1774; Hay, 1899; Ober, 1898; Praetorius, 1727; and Rochefort, 1658, 1665, 1666). In addition, several authors mentioned what was probably a second tyassuid on Tobago. Ponytz (1683, 1695) described both the "wild hogg" and "pickery" and listed the "hogg" separately among domestic animals. Anonymous (1749) stated that there were two kinds of wild hogs on Tobago, both having "the navel on the back" (a feature attributed to the peccary in the early literature). Woodcock (1867) mentioned both the wild hog and the "pieary". It is unlikely that the "wild hogs" of early writers were domestic swine (Suidae), and hunters, now living on Tobago, assure me that feral swine do not now occur there. The confusion between these two kinds of pig-like animals is clearly seen, however, in Niddrie's recent statement that "ferál pigs, known locally as quenca (the local name for peccary), having escaped from domesticity many generations ago, are too fleeting in their nocturnal raids upon provision grounds to enable people to shoot more than a few of them" (Niddrie, 1980).

I am persuaded that all or most of the animals mentioned above occurred on Tobago within the last four centuries, although I am unable to guess the identities of two of them (the "fox" and the "musk rat"). At least two of them occur there today: the collared peccary (*Tayassu tajacu*), and the crab-eating raccoon (*Procyon cancrivorus*). Specimens of both of these species, recently killed by local hunters, were secured during the 1979 expedition. During the same expedition, three additional species were added to the known mammal fauna of Tobago: the water rat (*Nectomys squamipes*), the rice rat (*Oryzomys* sp.), and the Paraguayan yellow-shouldered bat (*Sturnira lilium*).

There is a single specimen of the Dominican little wrinkled-lipped bat (*Tadarida brasiliensis antillularum*) from Tobago (USNM 102073). The supposed biogeographical significance of this specimen has been discussed by several authors (Baker and Genoways, 1978; Jones and Phillips, 1970; and Koopman, 1958, 1968) who regard it as the only bat to have reached Tobago from the West Indies (its range otherwise includes Puerto Rico and the Lesser Antilles). Unfortunately, the single Tobago specimen was collected by Frederick A. Ober while on his ornithological expedition to the southeastern Caribbean (Ober, 1879). It has

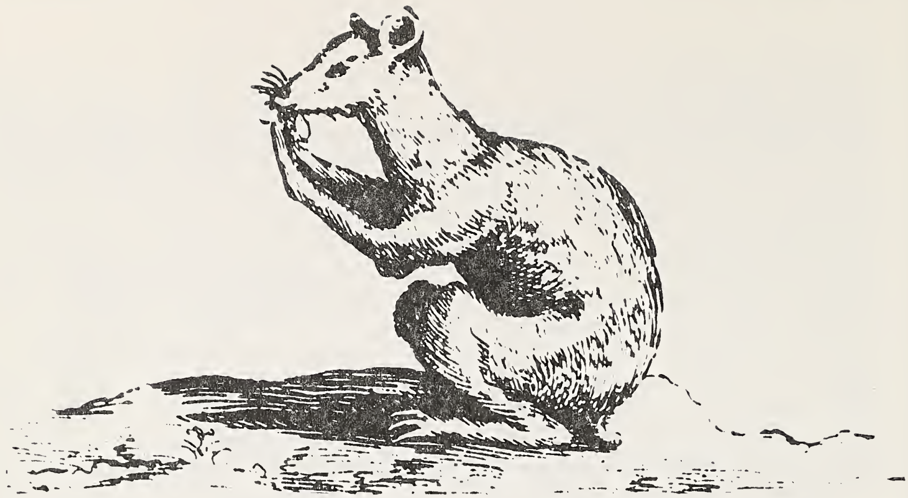


Figure 5. The "musk rat" of Tobago, identified by Allen (1911) as *Megalomys desmarestii* (from Rochefort, 1658).

Figure 6. Finding peccaries on Tobago in 1979 was surprising to me and my associates. It was not surprising to Frederick A. Ober who illustrated his plight in this figure labeled "treed by peccaries" (from Ober, 1898).

already been shown that, through some error of labeling or shipping, none of the amphibians and reptiles which Ober supposedly collected on Tobago actually came from there (Lazell, 1964; Tuck and Hardy, 1973). Although Ober (1898) specifically mentioned shooting a roosting bat on Tobago, he also mentioned observing or collecting bats on several islands north of Tobago (Ober, 1880). Although the actual source of Ober's specimen will probably never be known, it is probably best to eliminate *Tadarida brasiliensis antillularum* from the known bat fauna of Tobago, at least until additional specimens are secured from the island.

One of the most significant results of the 1979 expedition was the discovery of fossil vertebrates in and around Crusoe's Cave, Tobago (Fig. 7). This cave, although relatively small, is a part of a much larger collapsed cave system which can be traced from the sea cliff in which it opens to a point at least one half mile inland. Within this collapsed system, there remain three openings leading to two additional small caves. All three of these caves contained recent vertebrate fossils. Based on the interpretation of patterns on Indian artifacts found in one of the caves, some of these fossils may be as much as 1600 to 2000 years old (Harris, 1978). Much older fossils were found in a narrow band of manganese nodules located just below the entrance of Crusoe's Cave and in the limestone rocks above and below the manganese belt. These older fossils included a diversity of mammalian species such as deer, collared peccary, white-lipped peccary, rice rat, *Glyptodon*, and a number of kinds of bats (some undescribed) representing species and even families not now known to occur on Tobago. Bones of marine mammals and sharks teeth were also discovered, but not in direct association with Crusoe's Cave.

The deer is almost certainly *Mazama americana*, a species which lived on Tobago until very recent times. The two peccaries represent the two species observed by the ancient writers. Wing (1962) recorded both peccaries from fossil deposits in Trinidad, while Joseph (1838) clearly indicated that both species lived in Trinidad within recent times: "There are two species of quanco or musk hog; one called the picary, and the other the wild hog . . . Externally they resemble the hog, save that they have a gland on the dorsal spine". The rice rat (*Oryzomys*) is probably identical to the rice rat discovered in Tobago in 1979. It is interesting to note that, in spite of rather extensive trapping efforts on the island, *Oryzomys* has only recently been discovered there. Perhaps it was once wide-ranging (thus at Crusoe's Cave in the lowlands), but now occurs only in the highlands of the Main Ridge. It is perhaps worth noting, also, that *Oryzomys* sp. has been recovered from fossil deposits in Barbados (Ray, 1964). The occurrence of *Glyptodon* is not surprising: its presence on Tobago was, in fact, predicted by Ober nearly one hundred years ago (Ober, 1898), and it is known to have lived in Trinidad (Wing, 1962).

Sixteen native terrestrial mammals are now known from Tobago, while the number of bats has increased to 18 (taking into account the

Figure 7. Crusoe's Cave, Tobago. The dark band below the entrance contains fossil bearing manganese nodules, and fossils also occur in the limestone above and below the manganese band. All fossil-bearing material shown here was removed in 1981 by an independent expedition, and none of the fossils which it contained are currently available for study in Trinidad. (Photograph by Ralph Berthold)

elimination of *Tadarida* and the addition of *Sturnira lilium* and an unidentified bat, new for the island, collected by an amateur mammalogist in 1981). If all species reported from the island in the last four centuries are included, the number of terrestrial mammals increases to 24 (more than one half the number now known to occur in Trinidad), and one aquatic mammal (the manatee) is added.

The total Tobago mammal fauna is clearly of South American origin. Anthony (1942) postulated a land bridge origin, pointing out that "the continental fauna had lost forms by the time it had reached Tobago". The absence of some mammalian species on Tobago has been attributed to ecological factors by McNab (1971) and Smith and Genoways (1974) who note the occurrence on only one carnivorous bat.

Several endemic mammalian subspecies have been named (for example, see Osgood, 1910; Goodwin and Greenhall, 1961; and Goodwin, 1962); but the validity of some of these has been challenged (for example, Hershkovitz, 1962). The existence of distinguishable populations on Tobago, whether named or not, suggests long isolation.

According to Goodwin and Greenhall (1961), one bat, *Eptesicus melanopterus*, occurs on Tobago and the South American continent, but not in Trinidad. *Peroteryx macrotis macrotis* occurs in Tobago and on the South American mainland (Jones and Phillips, 1970), while *Peroteryx macrotis trinitatis* occurs on Trinidad and Margarita Island off the Venezuelan coast (Goodwin and Greenhall, 1961; Smith and Genoways, 1974).

Given the occurrence of rather rich fossil deposits, including such species as *Glyptodon*, on Tobago, the overall richness of the mammal fauna within the last four centuries, the occurrence on Tobago of distinguishable endemic mammal populations, and the occurrence of one South American species and one South American subspecies on Tobago, but not in Trinidad, one could easily hypothesize an ancient land bridge to Tobago, and regard at least some of the mammals now living there as land-bridge relics *sensu* Diamond (1972).

AMPHIBIANS AND REPTILES

Introduction

The earliest references to reptiles in Tobago concern sea turtles and are buried in the ancient writings of the Couronians who occupied the island from about 1639 to 1693 (Anderson, 1970). Other early writers (Rochefort, Ponytz, and Woodcock, for example) mentioned various turtles, lizards, and snakes, but gave few detailed descriptions. The earliest attempt to enumerate the amphibians and reptiles of Tobago was a paper by Cope (1879). This paper, listing 2 lizards, 2 snakes, and one frog, was, unfortunately, based on material collected by Frederick A. Ober in the Lesser Antilles. Apparently none of these specimens came from Tobago (Tuck and Hardy, 1973). Six years later, Boettger (1895) listed 4 snakes and a toad (*Bufo marinus*) from the island. Although Ober's specimens may not have come from Tobago, he did spend a considerable amount of time there, and, in fact, wrote a book about his adventures on "Crusoe's Island". This book is filled with vivid descriptions of frogs, snakes, turtles, and other animals (Ober, 1898). In 1910, Mole commented that "Tobago, so far as can be ascertained, has only six or seven snakes, and they are all harmless" (Mole, 1910).

In 1915, there appeared in the pages of *The West India Committee Circular* a delightful story of little scientific value which I repeat here, in part, just for the fun of it. The story was originally written by Mr. Robert Crooks, Inspector of Police at Milford, Tobago, and appeared in the pages of *The Tobago Official Gazette* (which I have not been able to locate). It tells of several encounters with boa constrictors, one of which "measured 12 feet", and concludes with the following:

> "We met about ten boas all in a lump - after taking a good look at them, we retired to a safe distance, and gave the heap the right and left barrels of two double guns, some remained, the rest, with a kind of moan, scattered in all directions - it was not a pleasant sight." (West India Committee, 1915)

One year later, Barbour presented a list of 3 amphibians, 12 snakes, and 7 lizards from Tobago (Barbour, 1916c). For forty years the herpetology of Tobago was largely ignored. Then, in 1956, Brongersma commented on several taxonomic problems involving reptiles of both Trinidad and Tobago (Brongersma, 1956a, 1956b). Underwood (1962) listed 11 lizards and 13 snakes from the island, and, in 1968, deVerteuil listed 10 lizards and 16 snakes (deVerteuil, 1968). Robert Mertens visited Tobago in the late 1960's and published a series of papers on his observations (Mertens 1969, 1970, 1972, 1973, 1974). In one of these (Mertens, 1972) he listed 10 frogs, 1 crocodilian, 16 lizards, and 20 snakes. Dinsmore (1970c) observed 8 lizards and one snake on Little

Tobago Island. Tuck (1972) added the lizard, *Hemidactylus palaichthus*, to the known herpetofauna of the island. In 1977 several major lists appeared: Emsley listed 21 snakes from the island; MacLean, et al, listed 2 frogs, 11 lizards, and 12 snakes; and Greenhall, in a list of snakes of Trinidad and Tobago, listed 17 snakes from Tobago, of which three were questioned. Bacon (1971, 1975) and Bacon and Maliphant (1971) provided useful data on the occurrence and breeding of sea turtles in Tobago.

Four species and one subspecies have previously been deleted from the known herpetofauna of Tobago (Lazell, 1964; Tuck and Hardy, 1973). These include:

Hylodes martinicensis (=Eleutherodactylus martinicensis)
Anolis alligator (=Anolis roquet roquet)
Eudryas amarali (=Mastigodryas bruesi ?)[1]
Bothrops lanceolatus
Amiva surinanensis tobaganus (=Ameiva ameiva tobagona)[2]

1) Stuart (1938) included a specimen, supposedly collected in Tobago, as a paratype of his *Eudryas amarali*, which is otherwise known only from "Margarita Island and dry areas in northeastern Venezuela" (Peters and Orejas-Miranda, 1970). This specimen most closely matches *Mastigodryas bruesi* of St. Vincent, the Grenadines, and Grenada.

2) Tuck and Hardy (1973) presented evidence to show that the type specimen of this subspecies probably came from Grenada.

Three additional species, all recorded from Tobago or as possibly occurring on Tobago, should be deleted. These include:

Pseudoboa coronatus

deVerteuil (1968) recorded *Pseudoboa coronatus* from Tobago, but did not list *Pseudoboa neuweidii* which is abundant on the island. Emsley (1977) pointed out that the Trinidad records of *P. coronatus* are probably based on mis-identified specimens of *P. neuweidii*. The same is certainly true of the Tobago record.

Leptophis riveti

Greenhall (1977) listed this species from Tobago, but questioned the inclusion. Boos (1975) citing Emsley (1963) noted that the Trinidad and Tobago specimen of this snake may have come from Tobago rather than Trinidad. Emsley (1963) commented as follows: "The inclusion of this species (in the Trinidad fauna) depends upon one specimen, now in the British Museum (Natural History), taken by Ivan Sanderson from an epiphyte 30 feet above ground in a tree at the top of Mount Aripo (3,000 feet). With it is a specimen of *L. ahaetulla caeruleodorsus* from

Tobago, so it is probable that both were taken on the same trip". The Tobago inclusion is pure speculation.

Typhlops lehneri

This snake does not occur on Tobago. For discussion, see the account of *Typhlops trinitatis* (p. 80).

Checklist

In the following checklist only those species marked with an asterisk (*) have been selected for discussion. These selections include species which have not previously been recorded from Tobago; species of obvious biogeographical importance; species of doubtful occurrence; and species in which there have been recent, significant taxonomic changes.

Depending on whether one includes doubtful and chance records, the current maximum and minimum number of amphibians and reptiles occurring (or possibly occurring) on Tobago may be broken down as follows:

	All taxons, including questionable and chance records	Questionable and chance records excluded
Frogs	14	13
Turtles	6	3
Lizards	17	16
Snakes	25	21
Crocodilians	2	1
Total	64	54

Amphibia

Salientia

Leptodactylidae

1) *Eleutherodactylus* of *rozei* Rivero *

2) *Eleutherodactylus terraebolivaris* Rivero *

3) *Eleutherodactylus urichi* (Boettger) *

4) *Leptodactylus fuscus* (Gunther)

5) *Leptodactylus* cf *pentadactylus* (Laurenti) *

6) *Leptodactylus wagneri* (Peters)

7) *Physalaemus pustulosus* (Shreve)

Bufonidae

8) *Bufo marinus* (Linnaeus) *

Hylidae

9) *Flectonotus* cf *pygmaea* (Boettger) *

10) *Hyla crepitans* Wied *

11) *Ololygon rubra* (Daudin) *

12) *Phrynohyas venulosa* (Laurenti) *

Centrolenidae

13) *Centrolenella* cf *orientalis* Rivero *

Dendrobatidae

14) *Colostethus* cf *dunni* (Rivero) *

Reptilia

Testudinata

Testudinidae

15) *Geochelone* sp. Fitzinger *

Emydidae

16) *Rhinoclemmys punctularia punctularia* (Daudin) *

Cheloniidae

17) *Caretta caretta caretta* (Linnaeus) *

18) *Chelonia mydas mydas* (Linnaeus)

19) *Eretmochelys imbricata* (Linnaeus)

Dermochelyidae

20) *Dermochelys coriacea coriacea* (Linnaeus)

Squamata

Sauria

Gekkonidae

21) *Gonatodes humeralis* (Guichenot)

22) *Gonatodes ocellatus* (Gray) *

23) *Gonatodes vittatus vittatus* (Lichenstein)

24) *Hemidactylus palaichthus* Kluge

25) *Hemidactylus mabouia* (Moreau de Jonnes)

26) *Sphaerodactylus molei* Boettger

27) *Thecadactylus rapicaudus* (Houttuyn)

Iguanidae

28) *Anolis richardi* Dumeril and Bibron *

29) *Iguana iguana* (Linnaeus)

30) *Polychrus marmoratus* (Linnaeus)

Scincidae

31) *Mabuya bistriata* (Spix) *

Teiidae

32) *Ameiva ameiva* (Linnaeus) *

33) *Bachia* cf *flavescens* (Bonnaterre) *

34) *Bachia heteropa alleni* (Barbour)

35) *Cnemidorphorus lemniscatus lemniscatus* (Linnaeus)

36) *Gymnophthalmus underwoodi* Granc *

37) *Tupinambis nigropunctatus* (Spix) *

Serpentes

Typhlopidae

38) *Typhlops trinitatis* Richmond *

Leptotyphlopidae

39) *Leptotyphlops tenella* Klauber *

Boidae

40) *Boa constrictor constrictor* Linneaus

41) *Corallus enydris cookii* Gray *

42) *Epicrates cenchria maurus* Gray

Colubridae

43) *Atractus trilineatus* Wagler

44) *Atractus* cf *univittatus* Jan *

45) *Clelia clelia clelia* (Daudin) *

46) *Drymarchon corias corias* (Boie)

47) *Erythrolamprus ocellatus* Peters *

48) *Imantodes cenchoa cenchoa* (Linneaus)

49) *Liophis melanotus* (Shaw)

50) *Liophis cobella* (Linnaeus) *

51) *Liophis* sp. Wagler *

52) *Leptodeira annulata ashmeadi* (Hallowell)

53) *Leptophis ahaetulla coeruleodorsus* Oliver

54) *Mastigodryas boddaerti dunni* (Stuart)

55) *Ninia atrata* (Hallowell)

56) *Oxybelis aeneus* (Wagler)

57) *Oxybelis fulgidus* (Daudin) *

58) *Oxyrhopus petola petola* (Linnaeus) *

59) *Pseudoboa neuwiedii* (Dumeril)

60) *Sibon nebulata nebulata* (Linnaeus)

61) *Spilotes pullatus pullatus* (Linnaeus) *

62) *Tantilla melanocephala* (Linnaeus)

Crocodilia

Crocodylidae

63) *Caiman crocodilus* (Linnaeus) *

64) *Crocodylus intermedius* Graves *

Species Accounts

Eleutherodactylus cf *rozei* (Figure 8)

Eleutherodactylus rozei was described on the basis of a single specimen from Curcuruma Edo. Aragua, Venezuela (Rivero, 1961). Additional specimens have subsequently been collected in the vicinity of Rancho Grande, Venezuela; and I have tentatively identified a black and white photograph of a frog from the Paria Peninsula, Venezuela (Roberto Donoso-Barros, personal communication) as *Eleutherodactylus rozei*.

A *rozei*-like *Eleutherodactylus* occurs in the mountains of Tobago. Comparisons of the Tobagonian specimens to *Eleutherodactylus rozei* from Rancho Grande, Venezuela, have shown consistent, but minor, differences in morphology, size, pigmentation, voice, and behavior. The Tobagonian frog may be a distinct species, but, if so, it is strikingly similar to *Eleutherodactylus rozei* of Venezuela.

Although Kenny (1969) recorded only one species of *Eleutherodactylus* from Trinidad (*E. urichi*), *Eleutherodactylus rozei* or *Eleutherodactylus* cf *rozei* may occur at high elevations in the Northern Range. This problem is currently under investigation.

Figure 8. *Eleutherodactylus* cf *rozei* from Tobago, photographed alive. This frog differs from *E. rozei* of Venezuela in pigmentation, size, call pattern, and behavior.

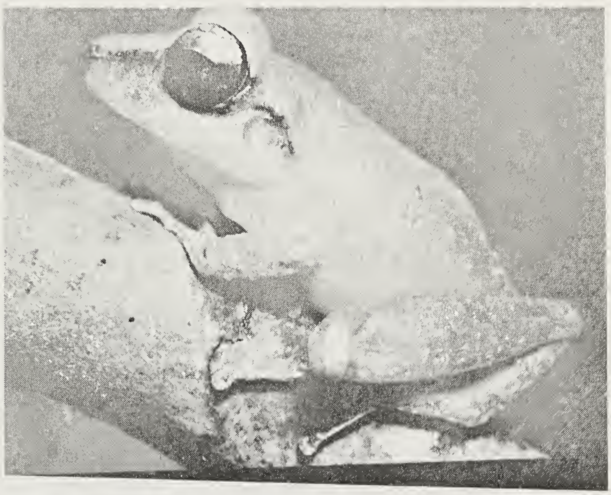


Figure 9. *Eleutherodactylus terraebolivaris* from Tobago, photographed alive. This frog appears to be identical to *E. terraebolivaris* from the Coastal Range of Venezuela.

Eleutherodactylus terraebolivaris (Figure 9)

Rivero (1961) described *Eleutherodactylus terraebolivaris* on the basis of a series of frogs from the Coastal Range of Venezuela. This species also occurs in the mountains of Tobago. Using preserved material, I have been unable to detect any significant difference between the Venezuelan and Tobagonian populations.

Eleutherodactylus terraebolivaris has not been recorded from Trinidad (Kenny 1969, 1977), and almost certainly does not occur there.

Eleutherodactylus urichi (Figure 10)

Eleutherodactylus urichi was originally described from Trinidad (Boettger, 1894). It has since been recorded from the islands of Tobago, Grenada, and St. Vincent; and from Venezuela, Guyana, and Suriname on the South American mainland (Barbour, 1914, 1916a, 1930; Crawford, 1931; Rivero, 1961, 1964; and Schwartz, 1967). Schwartz (1967) described *Eleutherodactylus urichi shrevei* from St. Vincent and *Eleutherodactylus urichi euphronides* from Grenada. He regarded the Tobagonian population as intermediate between *urichi urichi* of Trinidad and *urichi euphronides* from Grenada (thus *Eleutherodactylus urichi urichi* x *euphronides*).

Recent studies (still incomplete) have shown that *Eleutherodactylus urichi* probably does not occur on the South American mainland and that the Lesser Antillean "*urichi*" are not conspecific with *urichi* from from Trinidad and Tobago (Hardy, 1970).

Eleutherodactylus urichi is probably endemic to Trinidad and Tobago.

Leptodactylus cf *pentadactylus*

In his book on Tobago, Ober (1898) tells of a gourmet frog-leg dinner prepared by his companion, Thomas Ned. The frog involved, called by Ober the "crapaud, or great frog", was said to live in holes in the forest, coming out only at night. It was apparently not abundant, and consequently, was difficult to collect.

In 1979, I interviewed a number of older people in Tobago, several of whom recalled a large frog which once occurred on the island, is now extinct, and was used for food.

Ralph Eshelman (personal communication) states that there is, among his Crusoe Cave fossils, a very large leptodactylid femur. Unfortunately this extremely important bone has not been available for study;

Figure 10. *Eleutherodactylus urichi* from Tobago, photographed alive. This frog, characterized by bright blue pigment in the upper part of the eye and red pigment on the hind legs, is probably endemic to Trinidad and Tobago.

but Ober's observation and my interviews strongly suggest that it represents one of the large leptodactylids, probably *Leptodactylus pentadactylus*. *Leptodactylus pentadactylus* occurs in Trinidad (Kenny, 1969) where its population may have been reduced in recent times (Parker, 1933). *Leptodactylus fallax*, a very similar frog of the Lesser Antilles, has become extinct on three of the five islands from which it has been recorded (Schwartz and Thomas, 1975).

Bufo marinus

Zug and Zug (1979) included the islands of Cozumel (Mexico) and Trinidad in the natural range of *Bufo marinus*, while Bacon (1978) included Trinidad and St. Vincent. Ralph Eshleman (personal communication) informs me that he has recovered ancient bufonid bones from the fossil deposits at Crusoe's Cave, but these bones have not been available for study. In 1979, bones of *Bufo marinus* were found in one of the two inland caves of the Crusoe Cave system. Pottery shards found in this same cave suggest that at least some of these bones may be as much as 1600 to 2000 years old (Harris, 1978).

Tobago, like Trinidad, was almost certainly a part of the natural range of *Bufo marinus*. On the other hand, it is generally believed that this toad was introduced on St. Vincent and other islands of the Lesser Antilles (Barbour, 1961b; Grant, 1959; Groome, 1970; Schwartz and Thomas, 1975).

Flectonotus cf *pygmaeus* (Figure 11)

Rivero (1961) recorded "*Nototheca fitzgeraldi*" from Tobago, but pointed out that this species "may prove to be conspecific with *Nototheca pygmaea*". Mertens (1972) subsequently noted the occurrence of *"Nototheca" (=Flectonotus)* on Tobago, but did not identify the species. *Flectonotus fitzgeraldi* (Parker, 1933) is endemic to Trinidad (Duellman, 1977), while *Flectonotus pygmaeus* was originally described from the Coastal Range of Venezuela (Rivero, 1961).

I have examined specimens of *Flectonotus* from Tobago and find that they differ from both *Flectonotus pygmaeus* and *Flectonotus fitzgeraldi*, but are most similar to *F. pygmaeus*. All three populations (*pygmaeus*, *fitzgeraldi*, and cf *pygmaeus*) may ultimately prove to be conspecific. While there are several frogs on Tobago which are closely similar or identical to frogs which occur on the South American mainland, but not in Trinidad, *Flectonotus* cf *pygmaeus* is the least convincing example.

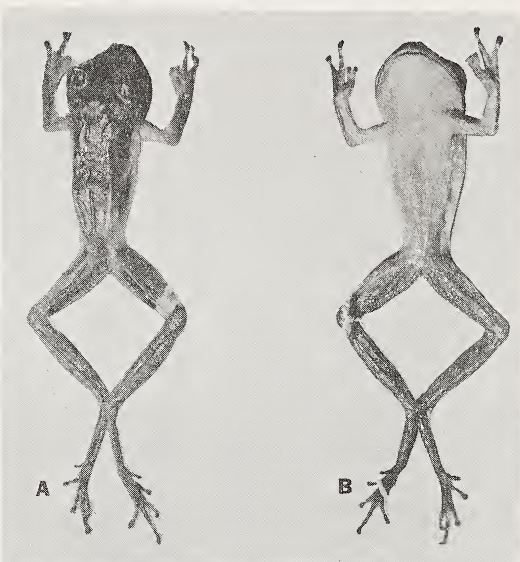


Fig. 11. *Flectonotus* cf *pygmaeus*. USNM 227786, St. John Parish, Tobago. A. Dorial view. B. Ventral view.

Hyla crepitans
Ololygon rubra

Duellman (1977), in his well-documented account of hylid frogs, excluded Tobago from the range of both *Hyla crepitans* and *Ololygon rubra* (although including the West Indian island of St. Lucia in the range of the latter). Both of these species occur abundantly throughout Tobago (Kenny, 1977; Mertens, 1970, 1972).

Phynohyas venulosa

Duellman (1956) first recorded *Phynohyas venulosa* from Tobago. Although recent material is limited, there appear to be minor but consistent differences in size, pattern, and voice between populations of this frog from the islands of Trinidad and Tobago. This problem, currently under study, substantiates Cochran and Goin's opinion that "the problem of variation in this species is no nearer solution today than it was when Duellman (1956) published his study" (Cochran and Goin, 1970).

Centrolenella cf *orientalis* (Figure 12)

Rivero (1968) described *Centrolenella orientalis* on the basis of a single specimen from Mt. Turimiquire, Venezuela, and no additional specimens have since been collected from the South American mainland.

A species of *Centrolenella*, strikingly similar to *Centrolenella orientalis*, occurs abundantly in the mountains of Tobago. Without additional material from the mainland, it is virtually impossible to decide if the Tobagonian frog is or is not *Centrolenella orientalis*. In 1977, I published a brief note establishing the fact that a *Centrolenella* does, indeed, occur on Tobago; but elected not to identify it as *orientalis* because of the lack of additional mainland material. Later that year, Duellman (1977) in his well-documented review of hylid frogs, stated that the range of *Centolenella orientalis* includes "the mountains of northeastern Venezuela and Tobago". Zweifel (1977) in reviewing Duellman's paper, stated that "the inclusion of Tobago in the range of a species [*Centrolenella orientalis*] known previously only from a single specimen from a montane, mainland locality 370 kilometers away should be documented". Lacking specimens, Duellman was unable to do so.

The Tobago *Centrolenella* cannot be properly identified until someone climbs Mt. Turimiquire and catches a few more frogs.

Figure 12. *Centrolenella* cf *orientalis* from Tobago, photographed alive. (Photograph by Robert G. Tuck)

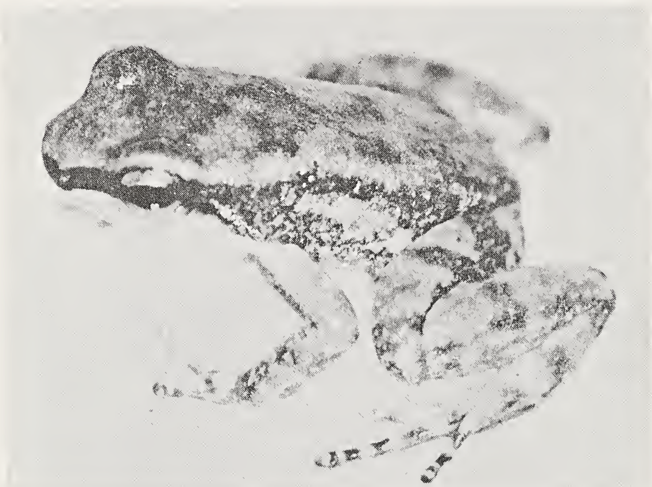


Figure 13. *Colostethus* cf *dunni* from Tobago, photographed alive. This frog is remarkably different from *C. Trinitatis* of Trinidad, but strikingly similar to *C. dunni* of the Coastal Range of Venezuela.

Colostethus cf *dunni* (Figure 13)

Mertens (1970) first recorded *Colostethus* from Tobago, using the name "*Pyllobates trinitatis*". Recent studies have shown, however, that the Tobagonian frog differs remarkably from *Colostethus trinitatis* of Trinidad (and, presumably, Venezuela).

Rivero (1961) described *Colostethus dunni* on the basis of a single specimen taken near Caracas, Venezuela, and additional specimens have since been taken from areas west of Caracas. The Tobagonian *Colostethus* is strikingly similar to *Colostethus dunni*. Although Hardy and Edwards (1974) have proposed a manuscript name for the Tobagonian *Colostethus*, I have not yet been able to examine recently collected specimens of *Colostethus dunni*, and the status of the Tobago frog remains unclear.

Geochelone sp.

Poyntz (1683, 1695) briefly mentions the occurrence of "land tortoises" on Tobago. In 1979, I talked to several older people in Tobago who recognized the name "marocoy" (the Trinidadian name for land turtles) and stated that this turtle was once rather abundant on Tobago. In addition, several local hunters insisted that the marocoy still occurs in remote parts of the island. There is, unfortunately, no direct evidence to support any of these statements.

A captive population of *Geochelone* (containing both *G. denticulata* and *G. carbonaria*) was released near Speyside, Tobago, several years ago, and tortoise shells have since been found on several occasions in the surrounding forests. Specimens of *Geochelone* have occasionally been taken in other parts of the island, but these have always been found in or near villages and are probably escaped pets.

The history of *Geochelone* in Tobago may parallel that suggested for Grenada by Groome (1970), who felt that a now-extinct population of *Geochelone* existed on both Grenada and the Grenadines. *Geochelone* has now "been re-introduced" as "escapes" on Grenada. *Geochelone carbonaria* has been clearly introduced on a number of islands between Grenada and the Virgin Islands (Schwartz and Thomas, 1975). On the other hand, fossils of *Geochelone* are known from Quaternary deposits in Barbados, Curacao, Cuba, Mona, and Sombrero (Ray, 1964).

If a natural population of *Geochelone* exists (or did exist) on Tobago, it is probably *G. denticulata*. This species occurs on Trinidad; *G. carbonaria* does not (Williams, 1960).

Rhinoclemmys punctularia punctularia (Figure 14)

Poyntz (1683, 1685) mentions that there were, in fact, two kinds of "land tortoises" in Tobago: one lived on land, the other in water. The water-turtle may have been *Rhinoclemmys*, although there is no direct evidence to support this.

There are reports of fresh-water turtles having been seen in the rivers near Hillborough Dam, Tobago, but so far none of these have been captured. Occasional specimens of *Rhinoclemmys punctularia punctularia* are captured in Tobago. These may be escaped captives, or may have drifted to Tobago on the Orinoco current. Freytey, et al (1977) show localities for this species in open marine waters of the coast of north-eastern South America. It is obviously a salt-tolerant species which could easily survive drifting to Tobago.

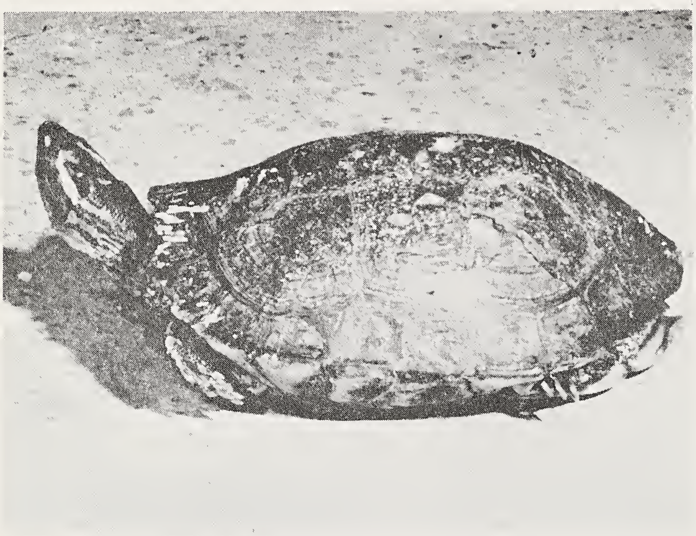


Figure 14. *Rhinoclemmys punctularia punctularia* taken in a beach seine at Bloody Bay. The specimen was retained by the fisherman who caught it.

Caretta caretta

Both Niddrie (1980) and Rebel (1974) mention the occurrence of the loggerhead turtle in Tobago, but provide no documentation. Recent reviews of the sea turtles of Trinidad and Tobago list the loggerhead as rare in Trinidad and give no records for Tobago (Bacon, 1971; Bacon and Malipant, 1971). Additional information is needed on the occurrence of this turtle in Tobago.

Gonatodes ocellatus

Gray (1831) gave no type locality for his "*Crydodactylus ocellatus*" (=*Gonatodes ocellatus*); but Boulenger (1885) subsequently established the type locality as Tobago. *Gonatodes ocellatus* has since been recorded from Grenada (Donoso-Barros, 1968), Trinidad (Brongersma, 1956a; Roux, 1926; Underwood, 1962), Margarita, and the Venezuelan mainland (Donoso-Barros, 1968; Roze, 1964). Peters and Donoso-Barros (1971) correctly eliminated Grenada from the species range. All records of "*Gonotodes ocellatus*" from Trinidad are based on *Gonatodes ceciliae*, a species originally described from Venezeula (Donoso-Barros, 1966). *Gonatodes ocellatus* does not occur on Trinidad. Roze (1964) recorded "*Gonatodes ocellatus* ? (Gray)" from Margarita, and included Marcuzzi's "*Gonatodes* cf *confidentatus*" in the synonymy of the Margarita lizard (Marcuzzi, 1950). He stated the range of *Gonatodes ocellatus* as " . . . Tobago, Trinidad y la tierra firme adyacente, inclusive el oriente de Venezuela", but gave no specific records for the Venezuelan mainland. Rivero-Blanco (1968) did not include *ocellatus* in his list of Venezuelan *Gonatodes*.

From all of this, it seems that Boos, in discussing the occurrence of *Gonatodes ocellatus* on Tobago, is correct in his statement that this lizard "is probably found no where else in the World" (Boos, 1977). I regard *Gonatodes ocellatus* as wholly endemic to Tobago, but find it interesting that an apparently very similar lizard occurs on Margarita and, presumably, in northern Venezuela.

Anolis richardi

Anolis richardi occurs on Grenada, the Grenadines, and Tobago (Schwartz and Thomas, 1975). Lazell (1972) revised the type locality of this species from Tortula (Dumeril and Bibron, 1837) to Tobago, and noted that it is "abundant all over Tobago". Gorman and Kim (1978), on the other hand, pointed out that, on Tobago, *Anolis richardi* "behave like weeds that are commensal with man" and are not found in natural forests or the highlands (as they are in Grenada). Based on these observations, they assumed a recent introduction from the Grenada Bank.

Bones of *Anolis richardi* were recovered from the floor of one of the caves in the Crusoe Cave system from depths considerably in excess of the maximum depth at which shards were found. Based on the approximate age of these shards, some of the *Anolis* bones could be as much as 1600 to 2000 years old (Harris, 1978).

It is perhaps worth mentioning that anoles are, indeed, subject to rafting. In 1979, a single *Anolis richardi* was rescued from a drifting tree approximately one mile off the mouth of Man-o-War Bay, Tobago, in the vicinity of St. Giles Island.

Mabuya bistriata (Figure 15)

Reboucas-Spieker (1981) comments that "*Mabuya mabauya mabouya*", as previously defined, includes the wide-ranging South American species, *Mabuya bistriata*. This is the species which occurs on Tobago.

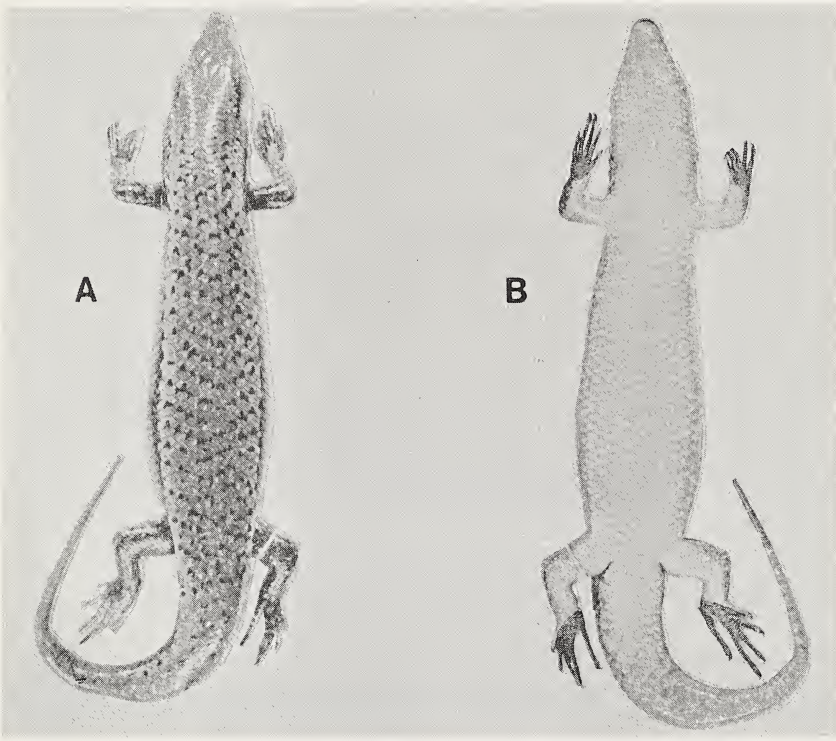


Figure 15. *Mabuya bistriata*. USNM 227932, Charlotteville, Tobago. A: Dorsal view. B. Ventral view.

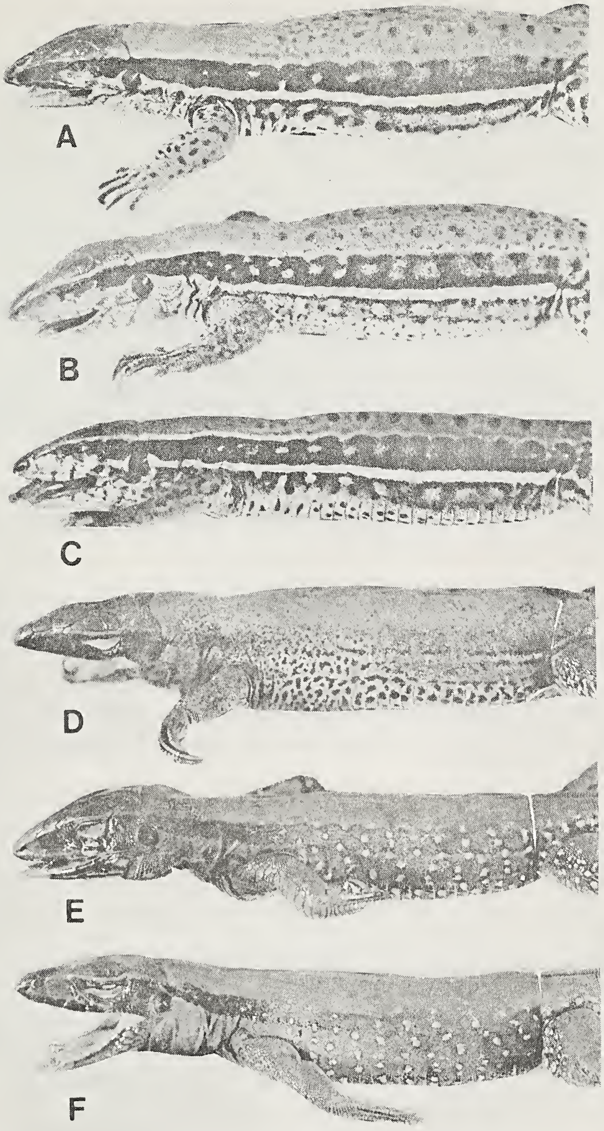


Figure 16. *Ameiva ameiva* showing typical patterns from the islands of Trinidad and Tobago. A, B, C. *Ameiva ameiva* subsp. from St. John Parish, Tobago. A. USNM 195082. B. USNM 195073. C. USNM 195077. D. E. F. *Ameiva ameiva atrigularis* from Maracas, Trinidad. D. USNM 166635. E. USNM 166638. F. USNM 166636.

Ameiva ameiva subsp. (Figure 16)

Tuck and Hardy (1971) concluded that the holotype of Cope's "*Ameiva suranamensis tobagonus*" (Cope, 1879) was actually collected in Grenada, not Tobago. Mertens (1974) objected to this, pointing out that one of the characters used in their comparison (the presence or absence of a well-developed white stripe on the body between the front and hind legs) is sexually dimorphic. In Tobago this stripe is well-developed in both males and females, disappearing only in extremely large individuals of both sexes. In Grenada it is never well-developed.

Barbour and Noble (1915) and Barbour (1916) regarded populations of *Ameiva* from the islands of Trinidad and Tobago as distinct, calling the Trinidad lizard *Ameiva atrigularis* (Garman, 1887), and the Tobago lizard *Ameiva tobagona* (Cope, 1879). Brongersma (1956a), on the other hand, felt that these two populations were con-subspecific and called them both *Ameiva ameiva tobagona*, an arrangement subsequently followed by Baskin and Williams (1966).

The well-developed lower lateral stripe which distinguishes Tobagonian *Ameiva* from *Ameiva ameiva tobagona* of Grenada also separates the Tobago lizards from the Trinidad population. Boos (1978), noting other differences between these populations, stated that "In Tobago the Zandolies [*Ameiva*] seem to grow larger and heavier, and in the hot, brassy sun around Crown Point, their size and beauty seem to have reached the ultimate."

The occurrence of a well-defined color pattern in Tobago suggests long isolation from other populations.

Bachia cf *flavescens* (Figure 17)

Bachia flavescens (Bonnaterre, 1789) is known on the basis of five specimens from Guyana on the South American mainland. Two subspecies, *Bachia f. flavescens* and *Bachia f. schlegeli* (Dumeril and Bibron, 1839) are recognized (Dixon, 1973).

A species of *Bachia,* closely similar to *Bachia flavescens,* occurs on Tobago. It is known on the basis of three specimens from the vicinity of Hillsborough Dam where it occurs sympatrically with *Bachia heteropa.*

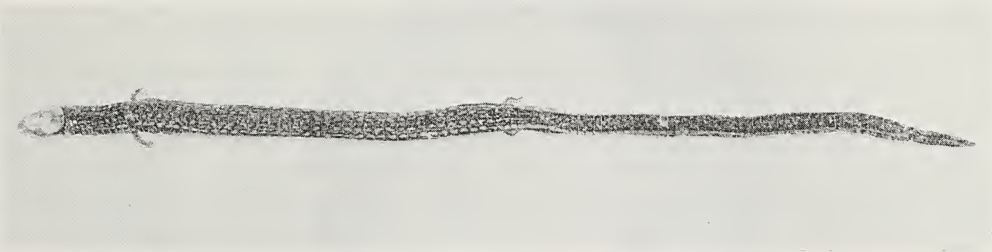


Figure 17. *Bachia* cf *flavescens*, Hillsborough Lake, Tobago, USNM 22743.

Gymnophthalmus underwoodi

Although Peters and Donoso-Barros (1971) include Tobago in the range of *Gymnophthalmus underwoodi*, I know of no specimens from the island, and therefore regard this inclusion as provisional. *G. underwoodi* is otherwise known from the islands of Trinidad, Barbados, St. Vincent, Guadeloupe (Grant, 1958; Schwartz and Thomas, 1976), and Grenada (unpublished data); and from Venezuela, Guyana, Suriname, and French Guyana on the South American mainland (Hoogmoed, 1973; Hoogmoed and Lescure, 1975).

Tupinambis nigropunctatus

Mertens (1969, 1972, 1974), in discussing the reptiles of Tobago, regarded *nigropunctatus* as a subspecies of *Tupinambis tequxin* (thus *T. tequxin nigropunctatus*). Presch (1973) placed *nigropunctatus* in the synonymy of *Tupinambis tequxin*, and included Tobago in the range of *T. tequxin*. Hoogmoed (1973), in reviewing these lizards, concluded that *Tupinambis nigropunctatus* occurs in Trinidad and Tobago and on the South American mainland north of the Amazon River, while *Tupinambis tequxin* occurs only south of the Amazon. The name *T. nigropunctatus* has been previously applied to

The Tobago tegu by Barbour (1916c), de Verteuil (1968), and Everard and Boos (1975).

Typhlops trinitatis (Figure 18)

Emsley (1963) recorded *Typhlops* cf *lehneri* (Roux, 1926) from Trinidad on the basis of a single specimen collected in 1956 by James Oliver (AMNH 89820). Richmond (1965) described *Typhlops trinitatis* on the basis of the same specimen. Underwood (1962) recorded *Typhlops* sp from Tobago, referring to a specimen collected at the Scarborough burial grounds. Thomas (1974) compared this specimen to the type of *Typhlops trinitatis* and to a series of *Typhlops lehneri* from Venezuela, and concluded that it was *Typhlops trinitatis*. Emsley subsequently identified the same specimen as *Typhlops lehneri* (Emsley, 1977). Hardy (1979), following Emsley, mentioned *Typhlops lehneri* as one of a number of South American plants and animals which occur on Tobago but not on Trinidad. Dixon and Hendricks (1979) recorded *Typhlops trinitatis* only from Trinidad, specifically listing only the holotype, but gave scale counts based on "two known specimens" (presumably including the Tobago specimen).

The Tobago snake, first mentioned by Underwood (1962) is *Typhlops trinitatis*, not *Typhlops lehneri*. *Typhlops lehneri* does not occur on Tobago. Seven specimens of *Typhlops trinitatis* are now available from Tobago. It is odd that no additional specimens of *T. trinitatis* have been collected in Trinidad.

Leptotyphlops sp.

De Verteuil (1968) listed *Leptotyphlops albifrons* from Tobago, noting that this snake "may be found in gardens" on the island. *Leptotyphlops albifrons*, however, is known only from a limited area in Brazil (Peters and Orejas-Miranda, 1970). Mertens (1972) cited de Verteuil's record of *Leptotyphlops*, but did not identify the species.

According to Peters and Donoso-Barros (1976), two species of *Leptotyphlops (goudoti* and *tenella)* occur on Trinidad. Emsley (1977) lists *Leptotyphlops tenella* from both Trinidad and Tobago, noting that *L. goudoti* is known, regionally, only from Patos Island but "may occur on Trinidad". Boos (1975) discusses the use of the names *albifrons, goudoti,* and *tenella* as applied to *Leptotyphlops* in Trinidad. Schwartz and Thomas (1975) record both *Leptotyphlops, tenella* and *L. goudoti* from the West Indies, but note that the single record of *Leptotyphlops tenella* (from Antigua) is questionable.

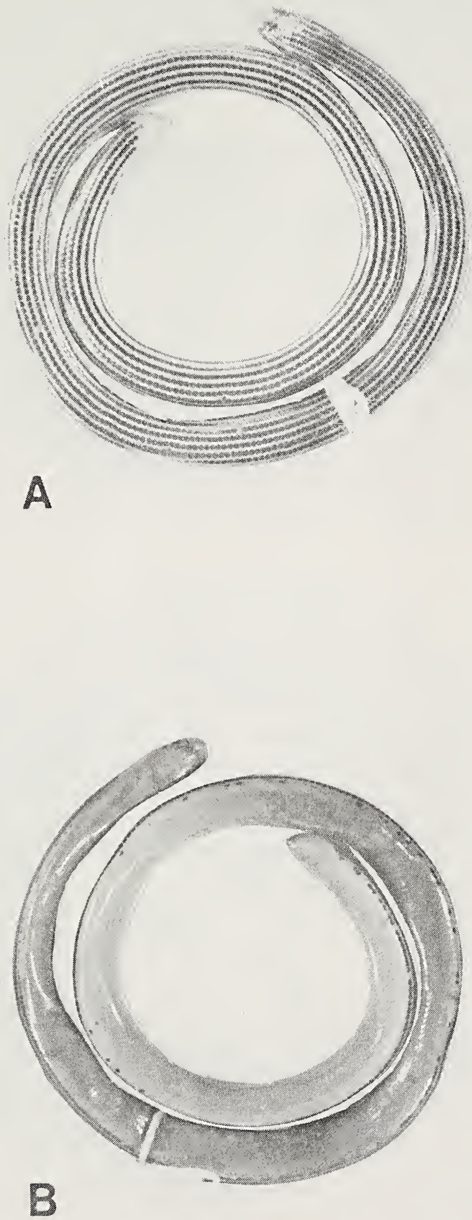


Figure 18. *Typhlops trinitatis*, near Roxborough, Tobago, USNM 228131. A. Dorsal view. B. Ventral view.

It is perhaps significant that de Verteuil (1968) did not include *Typhlops* (a genus which *Leptotyphlops* superficially resembles) in his list of Tobago snakes. I know of no actual records of *Leptotyphlops* from Tobago, and consider the inclusion provisional.

Corallus enydris cookii (Figures 19 and 20)

Corallus enydris occurs on the South American mainland, and on the islands of Trinidad, Tobago, Grenada, St. Vincent, and the Grenadines (Schwartz and Thomas, 1975). It is a highly variable species throughout its range. On Tobago these snakes are typically yellow or yellowish-brown with or without very obscure markings. Well-marked specimens are rare. On Grenada *Corallus enydris* is somewhat more variable (Barbour, 1914; Underwood, 1964) but typical specimens are dark and have distinct, well-defined markings. Although both of these patterns, along with others, occur on snakes from the South American mainland, it is interesting to note that they have become more or less genetically fixed on Tobago (pale and un-marked) and Grenada (dark and heavily marked). *Corallus enydris* from Trinidad are similar to specimens from Tobago.

Atractus cf *univittatus* (Figure 21)

Atractus univittatus (Jan, 1862) is found in the Coastal Range of north-central Venezuela (Rose, 1966). In 1978 a single snake, strikingly similar to *Atractus univittatus* was captured in the forest above Charlotteville, Tobago. More Tobago specimens are needed before this very interesting snake can be identified with certainty.

Clelia clelia clelia

Barbour (1916c) recorded *Clelia clelia* (as *Clelia cloelia*) from Tobago on the basis of five specimens presumably in the collection of the Museum of Comparative Zoology. William Palmer (personal communication) recently examined specimens of "*Clelia*" from Tobago in the MCZ collection and identified them as *Pseudoboa neuwiedii*, a species with which *Clelia* has frequently been confused. I know of no other specimens of *Clelia* from Tobago, and therefore include this species with considerable doubt.

Schwartz and Thomas (1975) otherwise record *Clelia clelia* from Central and South America, and from Dominica, St. Lucia, and Grenada, where a distinct subspecies may occur (Greer, 1965; Peters and Orejas,

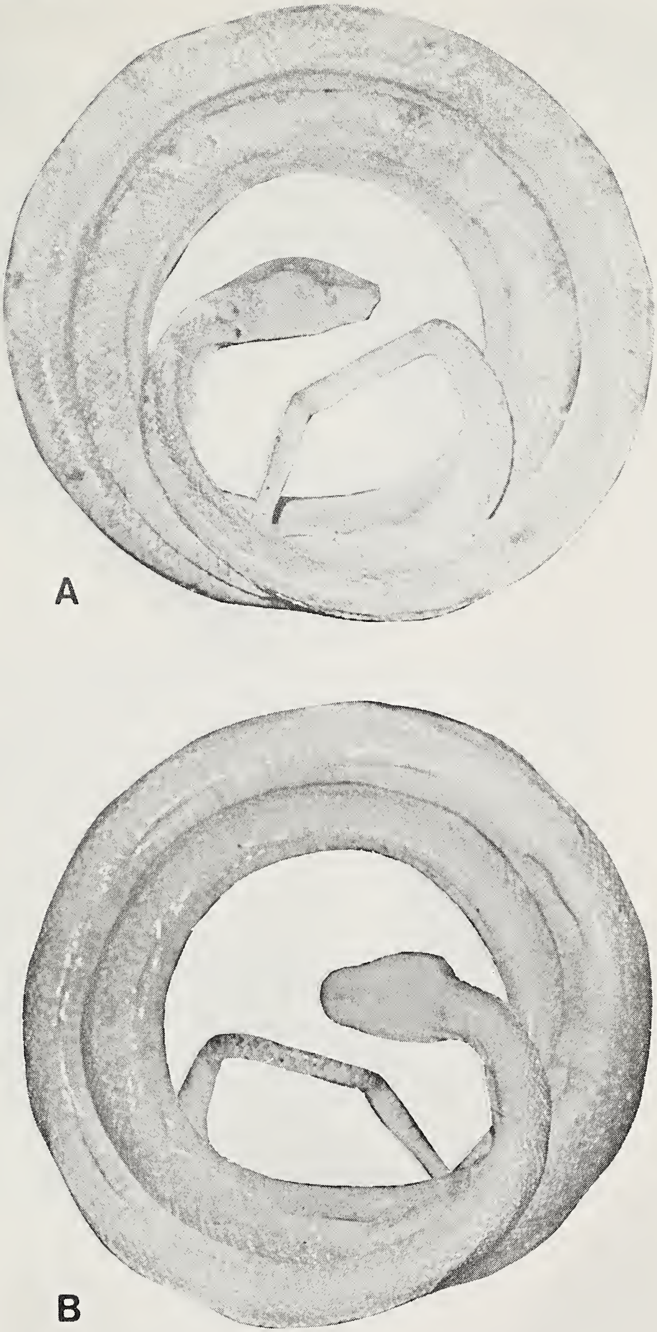


Figure 19. *Corallus enydris cooki* from Tobago, USNM 228018.
A. Dorsal view. B. Ventral view.

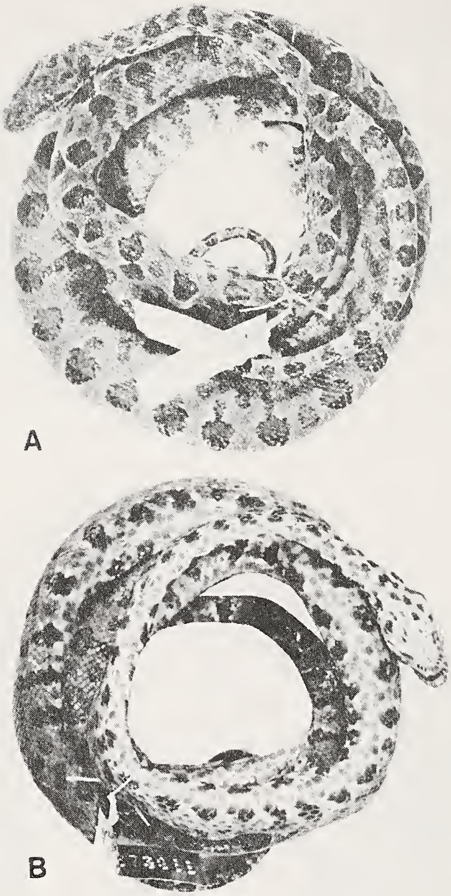
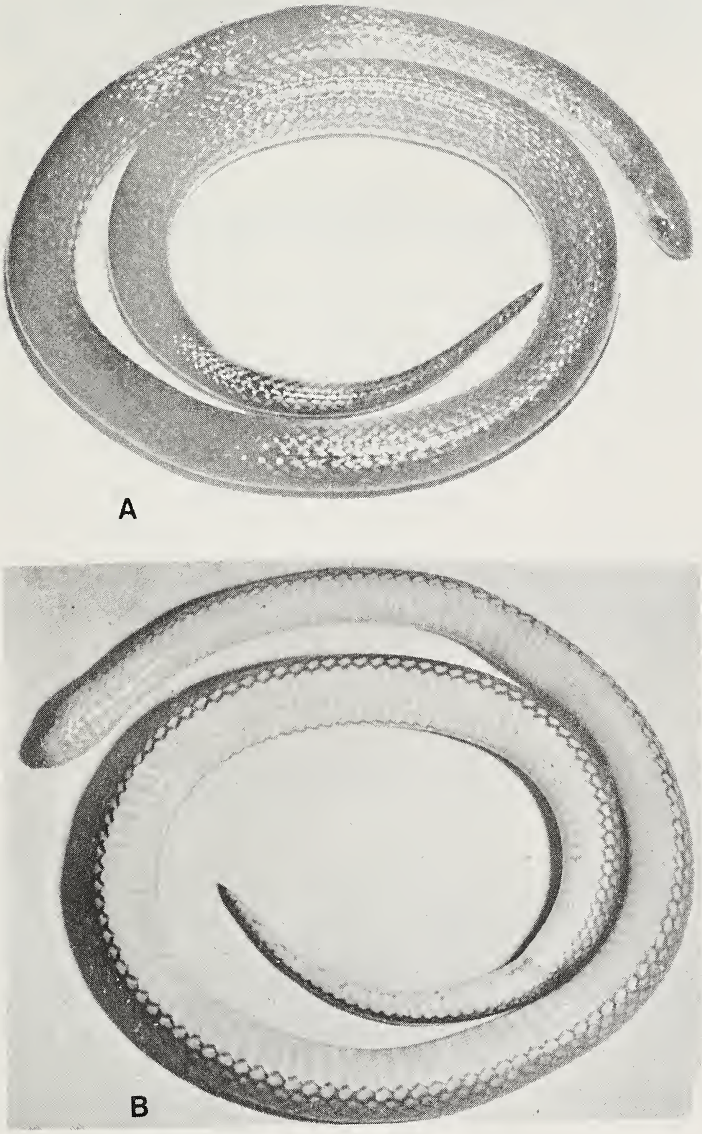


Figure 20. *Corallus enydris cooki* from Grenada, USNM 167398.
A. Dorsal view. B. Ventral view.



A

B

Figure 21. *Atractus* cf *univittatus*, near Charlotteville, Tobago, USNM 228024. A. Dorsal view.
B. Ventral view
(Photograph by Alvin Braswell)

1970). It also occurs on Trinidad (Boos, 1975; Greenhall, 1977; Mole, 1924; Wehekind, 1955). The fossil "*Pseudoboa* cf *P. cloelia*" [=*Clelia* cf *clelia*] from Barbados (Auffenberg, 1958) has, on the other hand, been identified as *Alsophis* sp., a typically West Indian genus (Schwartz, 1967).

Erythrolamprus ocellatus (Figure 22)

Hans Boos and I are currently studying snakes of the genus *Erythrolamprus* from Trinidad and Tobago. We have found convincing evidence to show that the single known specimen of *Erythrolamprus* from Trinidad is not conspecific with *Erythrolamprus aesculapii* (*sensu* Roze, 1966, and Peters and Orejas-Miranda, 1970). Emsley (1966a) examined the Trinidad specimen and concluded that it showed characteristics of both *E. aesculapii* and *E. ocellatus*. He therefore regarded *ocellatus* as subspecifically related to *aesculapii* and assigned the name *Erythrolamprus aesculapii ocellatus* to the Tobago population. On the basis of this supposed relationship to *aesculapii*, he later argued that *Erythrolamprus ocellatus* lost the annulated pattern typical of *aesculapii* (which mimics coral snakes throughout its range) after its arrival in Tobago. Loss of the annulated pattern was attributed to the absence of coral snakes on Tobago (Emsley, 1966b).

I regard *Erythrolamprus ocellatus* as a distinct species, endemic to Tobago.

Liophis cobella

Emsley (1977) includes this species in his list of snakes of Tobago (p. 221). In his species account, however, he states the distribution as "Tropical northern South America and east of the Andes and Trinidad" (p. 242). I have searched unsuccessfully for this snake in appropriate habitats in Tobago. Furthermore, I know of no museum specimens from the island. The inclusion of *Liophis cobella* is at best provisional.

Liophis sp (Figure 23)

An unidentified species of *Liophis* (*sensu* Dixon, 1980), known from a single specimen collected above 1000 feet on Pigeon Peak, occurs in Tobago. Morphologically this snake keys to "*Leimadophis*" *reginae* (Figure 24) in Emsley (1977) and Peters and Orejas-Miranda (1970), and

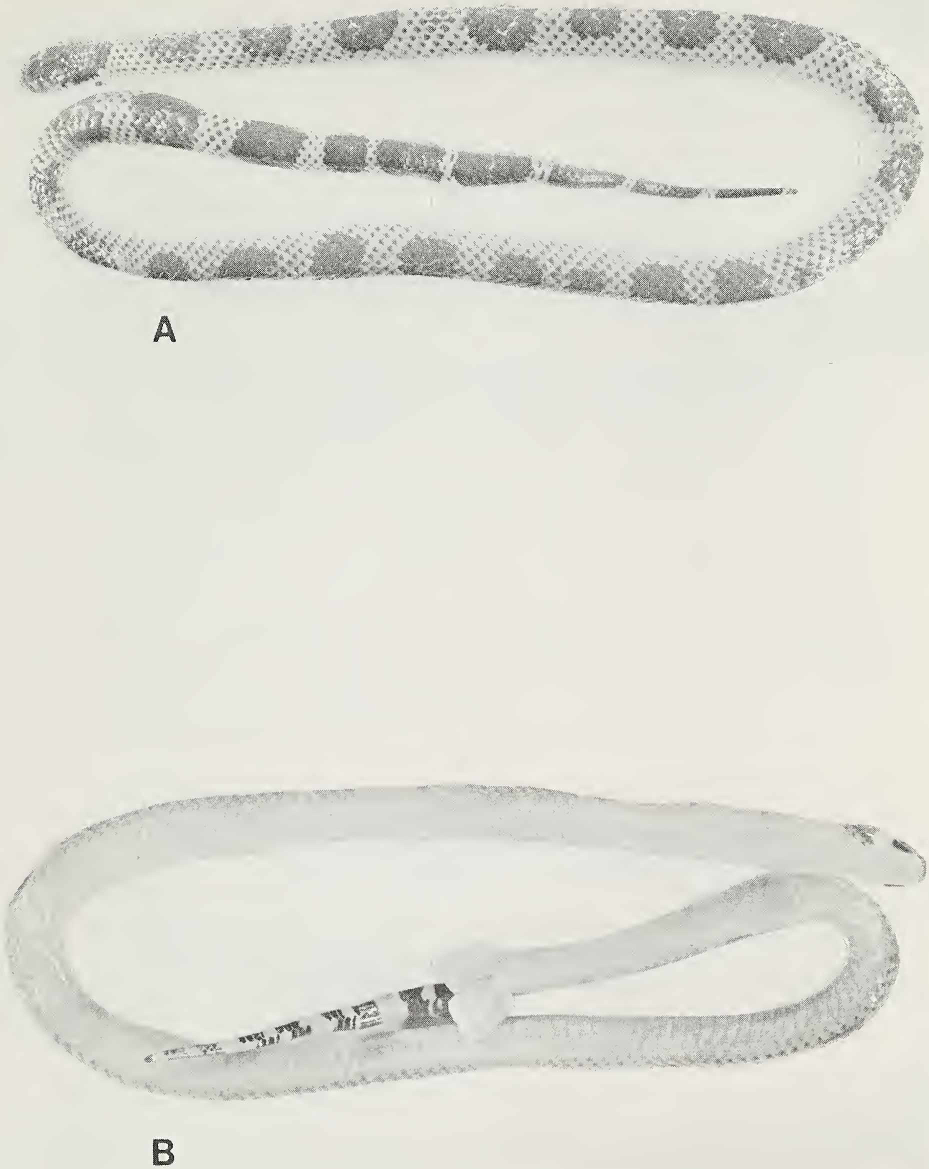


Figure 22. *Erythrolampsur ocellatus*, near Hillsborough Dam, Tobago, USNM 228058. A. Dorsal view. B. Ventral view.

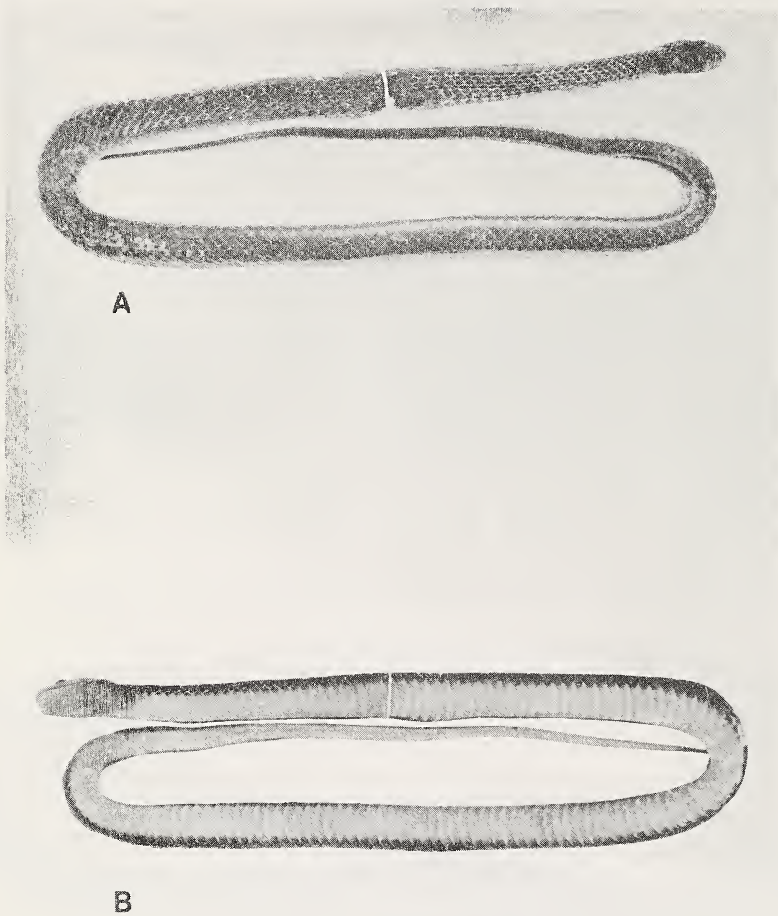


Figure 23. *Liophis* sp., near Charlotteville, Tobago, USNM 228069. A. Dorsal view. B. Ventral view.

to "*Leimadophis*" *zweifeli* (Figure 25) in Roze (1966), but the color pattern is distinct. Additional material is necessary before it can be specifically identified.

Oxybelis fulgidus

Underwood (1962) included this species, without documentation, in his list of reptiles of Tobago (but did not include *Oxybelis aeneus*, which is abundant on the island). Emsley (1963) recorded *Oxybelis fulgidus* from Patos Island (just off the Paria Peninsula between Venezuela and Trinidad), but pointed out that there are no authentic records from Trinidad. *Oxybelis fulgidus* is otherwise known from Mexico south through tropical America east of the Andes (Peters and Orejas-Miranda, 1970). The Tobago listing is extremely doubtful.

Oxyrhopus petola petola

Mertens (1972) recorded a single specimen of *Oxyrhopus petola* from the vicinity of Hillsborough Dam, Tobago. In 1979, a second speciment was collected above King's Bay, suggesting that this species is probably found throughout the highlands.

Spilotes pullatus pullatus (Figures 26 and 27)

Sternfeld (1920) described *Spilotes pullatus niger* from Tobago, on the basis of the typically melanistic pattern of specimens from the island. Amaral (1929) observed that melanistic specimens occurred more or less randomly throughout the range of the species, and placed *Spilotes pullatus niger* in the synonomym of *Spilotes pullatus pullatus*. Mole (1924) noted both normally-patterned and melanistic specimens in Trinidad, calling the former "tigre" and the latter "tigro".

All adult *Spilotes* from Tobago are distinctly melanistic. I have compared recent Tobago material to specimens in the collection of the United States National Museum of Natural History drawn from populations from throughout the range of the species. None of these show the degree of melanism observed in Tobago.

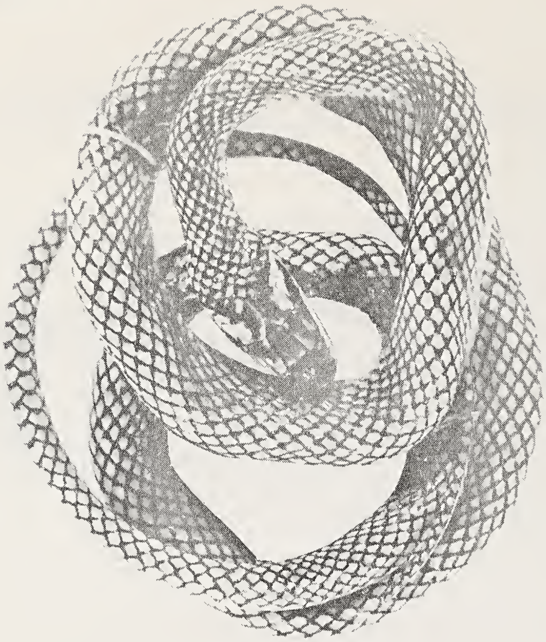


Figure 24. *Liophis reginae*, Trinidad, USNM 17757.

Figure 25. *Liophis zweifeli*, Venezuela, USNM 196332.

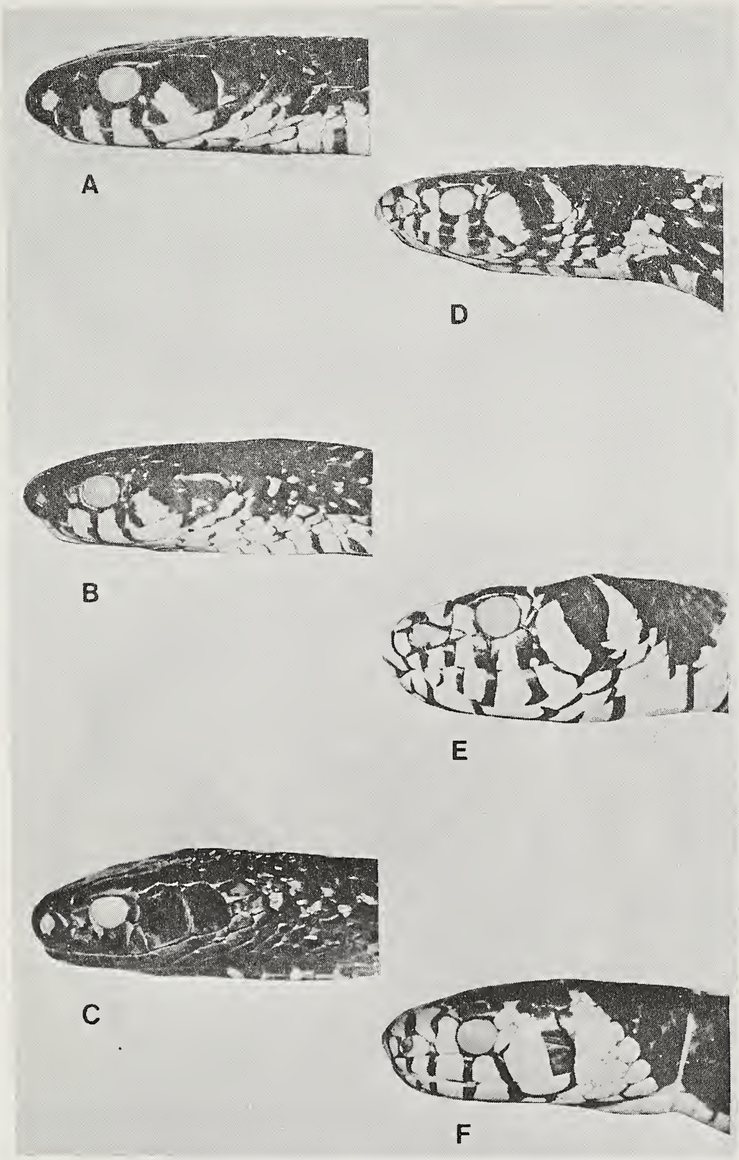


Figure 26. *Spilotes pullatus pullatus*, details of head pigment. A, B, C. Tobago. A. USNM 228125. B. USNM 228124. C. USNM 228123. D, E, F. South American mainland. D. Venezuela, USNM 132896. E. Peru, USNM 193748. F. Brazil, USNM 39064.

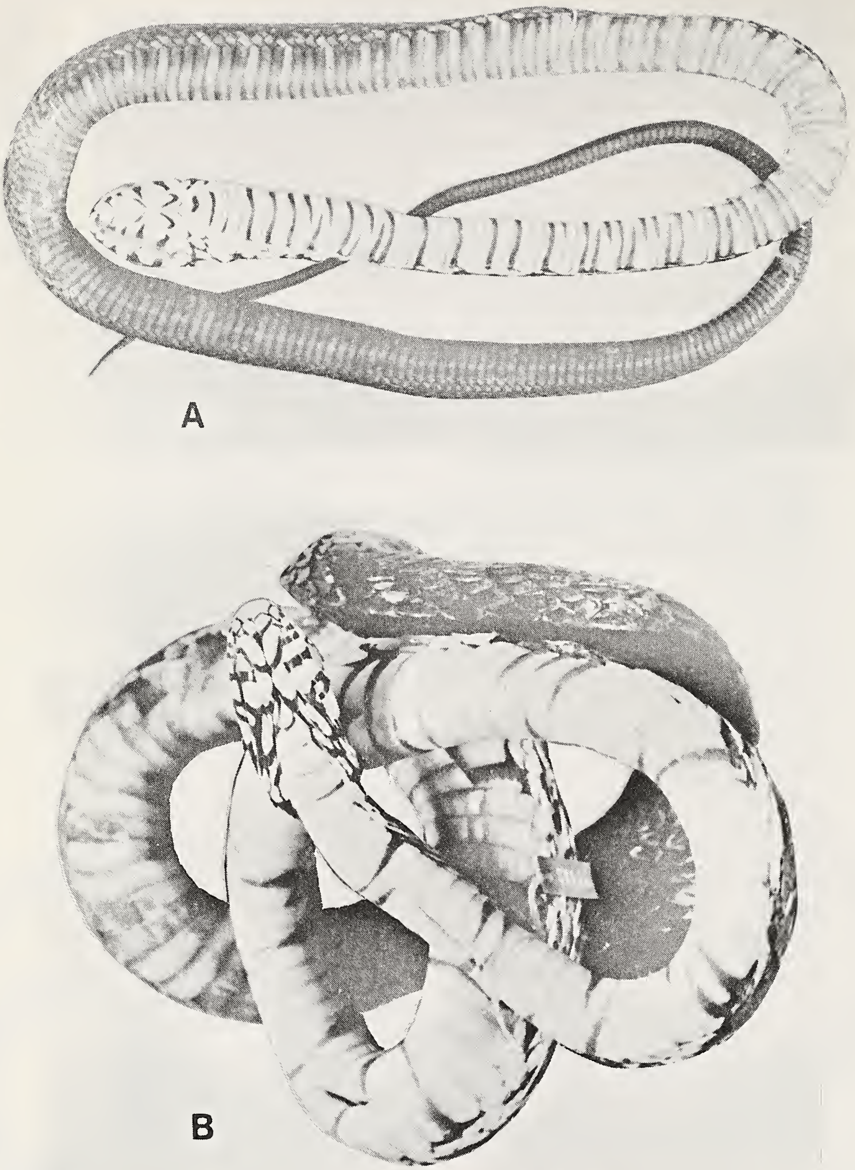


Figure 27. Ventral aspects of *Spilotes pullatus pullatus* showing increased density of black pigment in the Tobago population. Both specimens are juveniles. A. USNM 228122, St. John Parish, Tobago. B. USNM 71145, Sao Paulo, Brazil.

Caiman crocodilus crocodilus (Figure 28)

The caiman once occurred in most of the rivers and marshes of Tobago, but its range is now limited to a few rivers along the south coast and to the lake behind Hillsborough Dam where it is still quite abundant.

On the South American mainland, the maximum length of *Caiman crocodilus* has been variously estimated at lengths of 7 feet 9 inches to 8 feet 6 inches (Guggisberg, 1972; Medem, 1955; Neill, 1971). Woodcock (1867) pointed out that, in Tobago, the "alligator" [=caiman] seldom exceeds a length of six feet. Three caimans from Hillsborough Lake, considered large for the population from which they came, were 5'2", 5'5", and 5'7¼" in total length. Although this is indeed scant evidence, it suggests that the Tobagonian caiman is smaller than its mainland counterpart. This, in turn, suggests long isolation of the Tobago population.

On the other hand, caiman, like other large reptiles, are still being randomly drifted about in the Caribbean Sea. In August, 1979, Captain Isaac Augustine of Speyside, Tobago, killed a large caiman swimming in the ocean three miles off the northeast corner of Tobago. This specimen, apparently trapped in the currents north of Tobago, was probably on its way to Grenada, Barbados, or oblivion.

Figure 28. Biogeography in action: the caiman to which this head once belonged was killed three miles off Tobago swimming in the open ocean. Photographed by Ann Juneau.

Crocodylus intermedius

Woodcock (1867), in discussing the occurrence of the "alligator" on Tobago, states that "one has been taken seventeen feet long; it was killed in the Betsey's Hope River, where it had attached a man who was crossing the stream, but who fortunately escaped the monster. It has always been considered that this animal was a stranger, brought by the current from one of the continental rivers; the native alligators do not measure much over six feet, and I have not heard of any injury done by them to man". The animal involved was probably *Crocodylus intermedius*.

There are two records of crocodilians being rafted to islands in the southeastern Caribbean: one to Grenada in 1910 (Barbour, 1914; Devas, 1965; Groome, 1965; King, 1962), and one to Barbados in 1886 (Fielden, 1889; King, 1962). Both have been tentatively identified as *Crocodylus intermedius*.

Biogeography

Table I, compiled primarily from data presented by Schwartz and Thomas (1975), shows the distribution of frogs, lizards, and snakes which occur on Tobago and in the West Indies. In the table and the text which follows, the "Grenada Bank" refers to the islands of St. Vincent, Grenada, and the Grenadines; while the "Western Caribbean Islands" include Swan Island, Providencia, San Andres, and associated islands which are isolated in the western part of the Caribbean Sea.

Thirty-two percent (18) of the total number of frogs, lizards, and snakes occurring on or thought to occur on Tobago (56) are also found in the West Indies.

Of the total of 14 species of frogs which occur (or may have occurred) on Tobago, only 2 (ca. 14%) also occur in the West Indies. The range of one of these (*Leptodactylus wagneri*) is limited northward to the Grenada Bank; while the other (*Ololygon rubra*) is known in the West Indies only from St. Lucia. With the exception of *Bufo marinus* which was introduced into Barbados, there are no amphibians which are common to Tobago and Barbados (in fact, there are no indigenous amphibians on Barbados).

Seventeen lizards are thought to occur on Tobago. Of these, 10 (59%) are found in the West Indies. Two of these occur only on the Grenada Bank; one is found only on the western Caribbean Islands; two are found on the Grenada Bank and the western Caribbean Islands; five are found on the Grenada Bank and on islands north of Grenada; and one is found north of but not on the Grenada Bank. Four lizards are (or at one time were) common to Barbados and Tobago (thus including fossils of *Iguana iguana* as reported by Ray, 1964, and Swinton, 1937)

Of 25 snakes thought to occur on Tobago, 6 (24%) are also found in the West Indies. Of these, 3 are limited to the Grenada Bank; one is found on the Grenada Bank and islands north of the Grenada Bank; one (*Leptotyphlops tenella*) is absent from the Grenada Bank, but questionably recorded northward at Antigua; one (*Boa constrictor*) is found on the western Caribbean Islands, and north of, but not on, the Grenada Bank; and none are common to the Grenada Bank and the western Caribbean Islands (a pattern seen in two species of lizards). There are no snakes which are common to Tobago and Barbados.

Obviously lizards have been the most successful, and frogs the least successful West Indian "invaders". *Mabuya* has reached the Bahamas, the wide-ranging *Hemidactylus mabouia* has reached Cuba, and two species (*Thecadactylus rapicauda* and *Iguana iguana*) have reached the Virgin Islands. Snakes known to occur in Tobago have successfully reached only St. Lucia, Dominica, and the western Caribbean Islands.

Table 1

Distributions of amphibians and reptiles which occur on both Tobago and various West Indian islands

	Grenada Bank only	Western Caribbean Islands only	Grenada Bank and Western Caribbean Islands	Grenada Bank and north	Northward of, but excluding Grenada Bank	Barbados (plus other islands)	Comments
FROGS							
Leptodactylus wagneri	X						Grenada, St. Vincent, and the Grenadines.
Ololygon rubra					X		A disjunct population on St. Lucia.
LIZARDS							
Hemidactylus mabouia				X		X	Africa, Madagascar, Ascension. In South America north only to Guyana. Scattered West Indian localities north to Cuba.
Hemidactylus palaichthus					X		A disjunct population on Maria Island, St. Lucia.
Thecadactylus rapicauda				X			Scattered localities north to St. Croix.
Anolis richardi	X						Grenada and the Grenadines only
Iguana iguana				X		X	North to Virgin Islands, fossils from Barbados.
Mabuya sp. (taxonomy of genus under review)			X	X		X	Scattered localities north to Bahamas, also Western Caribbean Islands.
Ameiva ameiva			X				Swan Island, Providencia (subsp. fuliginosa); St. Vincent, the Grenadines, Grenada (subsp. tobagonus)
Bachia heteropa	X						Grenada.
Cnemidophorus lemniscatus		X					Swan Island, San Andres Island, Providencia, Isla Sta. Catalina
Gymnophthalmus underwoodi				X		X	Guadeloupe, St. Vincent, Grenada, Barbados.
SNAKES							
Leptotyphlops tenella					X		A questionable record from Antigua.
Boa constrictor					X		San Andres, Providencia, Isla Sta. Catalina (subsp. imperator); Dominica (subsp. nebulosa); St. Lucia (subsp. orophias)
Cozallus enydris	X						St. Vincent, the Grenadines, Grenada.
Clelia clelia				X			Dominica, St. Lucia (subsp. clelia); Grenada (questionable subsp. groomei)
Liophis melanotus	X						Grenada only.
Pseudoboa neuwiedi	X						Grenada only.

The most remarkable biogeographic feature of the herpetofauna of Tobago is the occurrence on Tobago of several amphibians and reptiles which are strikingly similar or identical to species occurring on the South American mainland. None of these occur in Trinidad (Figure 29). These include:

Eleutherodactylus cf *rozei*
Eleutherodactylus terraebolivaris
Flectonotus cf *pygmaea*
Centrolenella cf *orientalis*
Colostethus cf *dunni*
Bachia cf *flavescens*
Atractus cf *univittatus*

These Tobagonian populations vary widely in their degree of similarity to (or dis-similarity from) their mainland counterparts. Without biochemical testing and a careful analysis of vocal patterns (which now appear to be slightly different), it is impossible to distinguish the Tobago population of *Eleutherodactylus terraebolivaris* from the mainland population. *Centrolenella* cf *orientalis* cannot be properly diagnosed until additional specimens of *Centrolenella orientalis* are available from the mainland; and, likewise, *Atractus* cf *univittatus* cannot be properly diagnosed until additional material is available from Tobago. The genus *Flectonotus* is in need of review, and the provenance of "*Flectonotus* cf *pygmaea*" from Tobago remains unclear. Details of the morphology, pigmentation, and call structure of *Colostethus* cf *dunni* of Tobago are all very similar to details of morphology, pigmentation, and call structure of *Colostethus dunni* of Venezuela. These two populations can be distinguished from one another, but only barely so. The same generalization holds for *Eleutherodactylus* cf *rozei* of Tobago and *Eleutherodactylus rozei* of Venezuela, except that the differences here are more pronounced and there are additional differences in size and behavior. *Bachia* cf *flavescens* of Tobago differs from *Bachia flavescens* of Guyana primarily in the absence of an interparietal scale. In *Bachia flavescens* this scale is greatly reduced.

Sufficient material is now available to allow me to name three of these populations immediately (*Eleutherodactylus* cf *rozei*, *Colostethus* cf *dunni*, and *Bachia* cf *flavescens*) if I should choose to do so. Whether they should be named as species or subspecies is, at the very least, an exceedingly complex question. At the same time, in terms of adequately understanding the biogeographical significance of Tobago, it is an exceedingly important question.

At the present time there are no endemic amphibian species on Tobago, and only two endemic or possibly endemic reptile species (*Erythrolamprus ocellatus* and *Gonatodes ocellatus*). The relationships of one snake, *Liophis* sp., are entirely unknown, and it may ultimately prove to be endemic. There are also, at the present time, no endemic subspecies of amphibians, and only one endemic reptile subspecies,

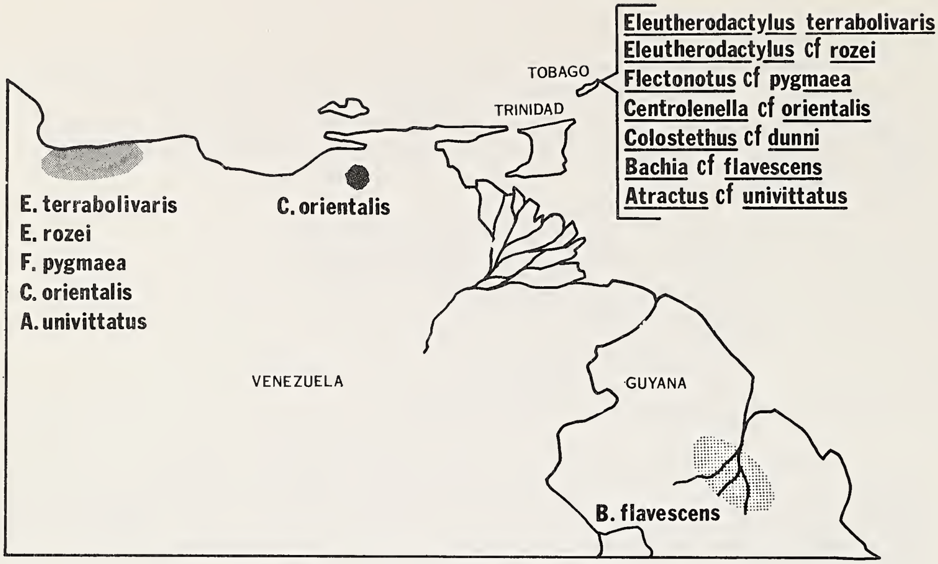


Figure 29. Distributions of South American amphibians and reptiles which are similar or identical to species occurring on Tobago. The range of *Flectonotus pygmaea* is poorly known. It may also occur in eastern Venezuela. *Eleutherodactylus rozei* may occur on the Paria Peninsula and in Trinidad.

although a number of un-named subspecies probably occur there (for example, *Ameiva ameiva* subsp.). The entire picture of Tobagonian endemism will certainly change once the "disjunct South American forms" are properly identified.

The herpetofauna of Tobago is clearly of South American origin. Although Gorman and Atkins (1969) suggest that *Anolis richardi* dispersed southward from the Grenadines, they also point out that the entire *roquet* species group, of which *Anolis richardi* is a member, originated in St. Lucia *by way of colinization from South America.*

Although there is little cause to question the South American nature of the Tobagonian herpetofauna, there is considerable cause to wonder how the Tobagonian herpetofauna arrived in Tobago. Boettger (1895) commented that Tobago was probably at one time joined to Trinidad "or that at any rate it obtained its Reptiles and Batracians by *active or passive migration* from this island" (italics are mine). Stated another way, Boettger's comment suggests that the Tobagonian herpetofauna may have arrived in Tobago by way of a direct land bridge (active migration) or by over-water transport (passive migration). This question has not yet been resolved.

DISCUSSION

The island of Tobago sits poised between South America and the West Indies. Its climate is more Antillean than that of its nearest neighbor, Trinidad. In a general sense, its total flora and fauna are of South American origin. Among the plants, however, there are a few strictly West Indian species, and several species which are common to the West Indies and the Venezuelan islands. With the exception of marine fishes, the strongest Caribbean influence among the animals is seen in insects and fresh-water invertebrates. A single bird, the Caribbean martin, and possibly a single mammal, the now-extinct Caribbean musk-rat, provide the only evidence of a Caribbean influence among the amphibians, reptiles, birds, and mammals of Tobago.

"Bond's Line", a faunal barrier between Tobago and Grenada, has been reasonably effective against birds, mammals, and amphibians, but essentially ineffective against reptiles. A number of kinds of reptiles are common to Tobago, Grenada and/or islands north of Grenada.

Dispersal northward into the Lesser Antilles has generally been attributed to over-water transport. Dispersal to Tobago, on the other hand, could have occurred over an ancient land bridge, over open water, or (most likely) through a combination of both.

The most unique biogeographic feature of Tobago is the occurrence there of several South American plants, birds, and mammals which do not occur on Trinidad, and of several amphibians and reptiles which are absent in Trinidad but are strikingly similar or identical to species occurring on the South American mainland.

All of these amphibians and reptiles are montane species in Tobago, as are most of their counterparts on the mainland. One could assume ancient continuous distributions of these species, and their consequent dispersal over a land bridge to what is now the island of Tobago. Tobago became separated from Trinidad long before the separation of Trinidad from the Paria Peninsula. Subsequent species competition, climatic factors, or other pressures caused the extinction in Trinidad and the lowlands of Venezuela of those species now seen as similar or identical to species which occur in Tobago today. The "South American disjuncts" thus become true land-bridge relics.

On the other hand, I have rescued an anole from a tree floating near Tobago, I have seen other reptiles drifting in marine waters under different circumstances (Hardy, 1977), and I have greeted a very astonished Captain Augustine as he came ashore one day with the severed head of a caiman killed three miles off Tobago. Guppy (1917) has written extensively of the dispersal of plant material from South America to Tobago, and the West Indian Committee (1923) has spoken of the "seed of a Moriche palm brought over from Venezuela by the outflow of the mighty rivers of the South American continent". I have already mentioned

Woodcock's account of a crocodile in Tobago (Woodcock, 1867) and the over-water transport of other animals to Trinidad and the West Indies has been discussed by Carr (1956), Guppy (1917), and King (1962).

The trouble with the land-bridge theory is that it demands a rather remarkable sequence of extinction events. Faaborg (1977) suggests that extinctions do take place, in fact, when land areas become isolated by water barriers, and that the magnitude of these extinctions is related to the size and degree of isolation of the resulting island. Jones (1980) has suggested the possibility of extinction in explaining the current distribution of frogs of the genus *Eleutherodactylus* in the Lesser Antilles; the extinction of birds has been documented in Barbados (Brodkorb, 1964); and the extinction of mammals, both historically and pre-historically, has been documented for Tobago (present study). The Tobago land-bridge theory demands that extinctions occurred on the larger and more shoreward of two adjacent islands (Trinidad) but not on the smaller island (Tobago) in spite of the fact that Tobago probably became geologically isolated much earlier than Trinidad.

The trouble with the theory of over-water transport to Tobago (as the only method of dispersal) is that I just can't buy it. I can not imagine, for example, any species of *Eleutherodactylus* making its way from Rancho Grande, Venezuela, down the Orinoco River, into the Atlantic Ocean, and out to Tobago; or making its way from Rancho Grande, down the northern slope of the Coastal Range, into the Caribbean Sea, and eastward to Tobago against the prevailing surface currents (as described by Wust and Gordon, 1964). Nor can I imagine *Centrolenella* (an exceedingly delicate frog) making a similar trip from Mt. Turimiquire, Venezuela, to the South American coast and then across open marine water to the island of Tobago.

The problem of dispersal to Tobago, then, remains exactly as it was before: Totally un-resolved.

In attempting to review what is known of the biogeography of Tobago, I have examined dispersal routes, effects of isolation, endemism, and disjunct populations. One key piece of the puzzle remains entirely unknown: Time. I believe that most of the dispersal of South American vertebrates to Tobago (and to the islands of the Lesser Antilles) took place much longer ago than has been generally supposed and that there was, historically, a time of peak dispersal. I intend, shortly, to set an electrophoretic clock which will help to determine the time of isolation of the "South American disjuncts" on Tobago as well as other similar disjunct populations throughout the Lesser Antilles.

In this review I have presented numerous problems and have quite obviously resolved none of them. It is perhaps appropriate, therefore, having opened the doors, to go back to the very beginning:

"Perhaps now the time is ripe for an upsurge of interest in Tobago's natural history, as distinct from that of Trinidad . . . [This] should certainly be of great interest to students of biogeography." (Trinidad and Tobago Field Naturalists' Club, 1975)

SPECIMENS EXAMINED

In the following list I have included only specimens of species selected for discussion in the text, and have limited inclusion primarily to specimens in the United States National Museum of Natural History.

Specimens listed under bracketed [ ] names are extra-limital. Specimens listed under non-bracketed names are all from Tobago.

Amphibians

Eleutherodactylus cf *rozei*

USNM 142723, Castara Rd, Mount St. George, 4 Oct 1959; USNM 192758-59, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity mile marker 27 3/4, near Hermitage, 22 July 1971; USNM 195136-37, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity mile marker 27 3/4, near Hermitage, 12 September 1972; USNM 195144-46, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity milestone 27 3/4, near Hermitage, 13 Sept 1972; USNM 227801-08, St. John Parish, 27.5 marker, Northside Rd, 3.75 mi WSW Charlotteville, 16 Dec 1978; USNM 227809, St. John Parish, 27.5 mile marker, Northside Rd, 3.-5 WSW Charlotteville, 20 Dec 1978: USNM 227810-13, St. John Parish, 27.5 mile marker, Northside Rd, 3.75 mi WSW Charlotteville, 21 Dec 1978; USNM 227814-18, St. John Parish, 27.5 mile marker, Northside Rd, 3.75 mi WSW Charlotteville, 22 Dec 1978; USNM 227819-31, St. John Parish, 27.5 mile marker, Northside Rd, 3.75 mi WSW Charlotteville, 23 Dec 1978; USNM 227832, St. John Parish, 27.5 mile marker, Northside Rd, 3.75 mi WSW Charlotteville, 30 Dec 1978.

[*Eleutherodactylus rozei*]

USNM 228147-52, Venezuela, Araqua State, Rancho Grande, 28 Dec 1978.

Eleutherodactylus terraebolivaris

USNM 167509-11, St. John Parish, Bloody Bay-Charlotteville Rd, vicinity mile marker 27 3/4, 1-2 July, 1970; USNM 167520, St. John Parish, Bloody Bay-Charlotteville Rd, vicinity mile market 27 3/4, 3 July 1970; USNM 167609-12, St. John Parish, Bloody Bay-Charlotteville Rd, vicinity mile marker 27 3/4, 2 July 1970; USNM 167613-14, St. John Parish, Bloody Bay-Charlotteville Rd, vicinity mile marker 27 3/4, 4 July 1970; USNM 167615, near Speyside, Windward Rd, mile marker 22.5, 6 July 1970; USNM 192760-61, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity mile marker 27 3/4, near Hermitage, 22 July 1971; USNM 192769, St. Paul Parish, Merchiston Rd, vicinity mile marker 1.5, 26 July 1971; USNM

195002, St. John Parish, Charlotteville, 29 Aug 1972; USNM 195003, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity mile marker 28 3/4, near Hermitage, 29 Aug 1972; USNM 195046-49, St. John Parish, Roxborough-Parlatuvier Rd, vicinity Bloody Bay, 31 Aug 1972; USNM 195098-100, St. John Parish, Roxborough-Parlatuvier Rd, vicinity Bloody Bay, 1 Sept 1972; USNM 195116-17, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity mile marker 28 3/4, 5 Sept 1972; USNM 195131, St. Paul Parish, Windward Rd, near Lambeau Hill Crown Trace, vicinity milestone 22 1/2, 9 Sept 1972; USNM 195135, St. Paul Parish, Windward Rd, near Lambeau Hill Crown Trace, vicinity milestone 22 1/3, 11 Sept 1972; USNM 195140, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity milestone 27 3/4, near Hermitage, 11 Sept 1972; USNM 195141-42, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity milestone 27 3/4, 13 Sept 1972; USNM 195161-62, St. Paul Parish, Windward Rd, vicinity milestone 22 1/2, near Lambeau Hill Crown Trace, 15 Sept 1972; USNM 227833, St. John Parish, Charlotteville-Bloody Bay Rd, mile marker 30, 15 Nov 1971; USNM 227834, St. John Parish, vicinity mile market 27 3/4, near Hermitage, 16 Nov 1971; USNM 227835, St. John Parish, Hermitage Bridge, 2 mi WSW Charlotteville, along Northside Rd, 16 Dec 1978; USNM 227836, St. John Parish, Northside Rd, mile post 28.5, about 1 2/3 WSW Charlotteville, 20 Dec 1978; USNM 227837-40, St. John Parish, Charlotteville, 20 Dec 1978; USNM 2378341-42, St. John Parish, Northside Rd, mile marker 27 1/4, 30 March 1979.

[*Eleutherodactylus terraebolivaris*]

USNM 117527-36, 128807-34, Venezuela, Miranda, Los Canales, no date; USNM 128835, Venezuela, Quebra Chacaito, 12 Feb 1939; USNM 128836, Venezuela, Camino de Galipan, Rio Catiza, no date; USNM 128884, Venezuela, Miranda, Curupao, July, 1940; USNM 142387-8, Venezuela, Araqua, Rancho Grande, Pico Peroquito, March, 1960.

Eleutherodactylus urichi

USNM 195143, 195147, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity milestone 27 3/4, 13 Sept 1972; USNM 227843, St. John Parish, Charlotteville, along Northside Rd, 18 Dec 1978; USNM 227844, St. John Parish, Northside Rd, milepost 27.5, 3.75 mi WSW Charlotteville, 21 Dec 1978; USNM 227845, St. John Parish, Northside Rd, milestone 27.5, 3.75 mi WSW Charlotteville, 22 Dec 1978.

Bufo marinus

USNM 194988, St. John Parish, Charlotteville, 28 Aug 1972; USNM 227727, St. John Parish, Hermitage Bridge, Northside Rd, 2 m WSW Charlotteville, 24 Dec 1978; USNM 227728, St. John Parish, Hermitage River Bridge, Northside Rd, 12 March 1979; USNM 227729, St. John Parish, Bloody Bay, 9 July 1979; USNM 227730-31, St. Mary, Hillsborough Dam, 16 July 1979.

[*Flectonotus fitzgeraldi*]

USNM 166625, Trinidad, St. George Co., Arima Valley, Spring Hill Estate (Asa Wright Nature Center), 6 Nov 1967 (catalogued as *Flectonotus pygmaea*).

Flectonotus cf *pygmaea*

USNM 192746, St. Paul Parish, Windward Rd, vicinity of milestone 22.5, Lambeau Crown Trace, 11 July 1971; USNM 195036, St. Paul Parish, Windward Rd, vicinity of milestrone 22.5, Lambeau Crown Trace, 30 Aug 1972; USNM 195041, St. John Parish, vicinity mile marker 27.5, near Hermitage; USNM 195158, St. Paul Parish, Windward Rd, vicinity milestone 22.5, Lambeau Crown Trace; USNM 227784-85, St. John Parish, mile post 27.5, Northside Rd, 3.75 WSW Charlotteville, 22 Dec 1978 (784), 23 Dec 1978 (285); St. John Parish, mile marker 31.3-31.4, Northside Rd, 1.25 m SW Charlotteville, 26 Dec 1978.

[*Flectonotus pygmaea*]

USNM 196335, Venezuela, Araqua State, Rancho Grande, 27 Nov 1967.

Hyla crepitans

USNM 167497-500, Roxborough-Parlatuvier Rd, vicinity of Bloody Bay, at Bloody Bay River, 30 June 1970; USNM 167501, Roxborough-Parlatuvier Rd, about 3 mi SE Bloody Bay, 30 June 1970; USNM 167502, Bloody Bay-Charlotteville Rd, vicinity mile marker 29 3/4, 5 July 1970; USNM 192747, Roxborough-Parlatuvier Rd, 18 July 1971; USNM 192955, St. Mary Parish, Windward Rd, vicinity mile marker 9 3/4, 21 July 1971; USNM 192756, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity mile marker 26, near Anse Fourmi, 22 July 1971; USNM 192757, St. Paul Parish, Windward Rd, vicinity milestone 18 1/4, near Roxborough, 22 July 1971; USNM 192766, St. Paul Parish, Windward Rd, vicinity milestone 18 1/4, near Roxborough, 24 July 1971; USNM 195006, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity of Hermitage, milestone 27 3/4, 29 Aug 1972; USNM 195103, St. Paul Parish, Windward Rd, vicinity milestone 22 1/2, near Lambeau Hill Crown Trace, 2 Sept 1972; USNM

195128, St. Paul Parish, Windward Rd., vicinity milestone 22 1/2, near Lambeau Hill Crown Trace, 8 Sept 1972; USNM 227784, St. John Parish, Speyside, Bird of Paradise Inn, 23 June 1979; USNM 227788, St. John Parish, Hermitage River Bridge, Northside Rd, near Hermitage, 12 March 1979; USNM 227787, St. John Parish, Northside Rd, mile marker 27.5, 3.75 mi WSW Charlotteville, 22 Dec 1978.

Ololygon rubra

USNM 192749, St. Paul Parish, Windward Rd, vicinity mile marker 22 1/2, near Lambeau Crown Trace, 19 July 1971; USNM 192963, St. Paul Parish, Windward Rd, vicinity mile marker 22 1/2, 19 July 1971; USNM 194990-98, St. Paul Parish, Windward Rd, vicinity of milestone 22 1/2, near Lambeau Hill Crown Trace, 28 Aug 1972; USNM 195115, St. John Parish, Charlotteville, 5 Sept 1972; USNM 195150-51, St. Paul Parish, Windward Rd, vicinity mile marker 22 1/2, near Lambeau Hill Crown Trace, 14 Sept 1972; USNM 227790-91, St. John Parish, Charlotteville, 13 May 1979; USNM 227792-95, St. Mary Parish, Hillsborough Dam, 16 July 1979.

Phrynohyas venulosa

USNM 192752, St. Paul Parish, Louis D'or Settlement, 19 July 1971; USNM 192754, St. Paul Parish, Louis D'or Settlement, 21 July 1971; St. John Parish, Charlotteville-Bloody Bay Rd, vicinity mile marker 27 3/4, near Hermitage, 13 Sept 1972; USNM 227796-800, St. John Parish, Bird of Paradise Inn, 23 June 1979.

[*Phrynohyas venulosa*]

USNM 166627, Trinidad, Churchill-Roosevelt Hwy, vicinity milestone 11 1/2, 17 Nov 1967; USNM 166628, Trinidad, Piarco Airport, Bel Air Hotel, 18 Nov 1967.

Centrolenella cf *orientalis*

USNM 192745, St. Paul Parish, Windward Rd, vicinity milestone 22 1/2, near Lambeau Crown Trace, 11 July 1971; USNM 194999-5000, St. Paul Parish, Windward Rd, vicinity milestone 22 1/2, near Lambeau Crown Trace, 28 Aug 1972; USNM 195031-35, St. Paul Parish, Windward Rd, vicinity milestone 22 1/2, near Lambeau Crown Trace, 30 Aug 1972; USNM 195039, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity milestone 30, near Hermitage, 30 Aug 1973; USNM 195040, St. John Parish, Charlotteville-Bloody Bay Rd, near Hermitage, vicinity milestone 27 1/2, 30 Aug 1972; USNM 195044-45, St. John Parish, Roxborough-Parlatuvier Rd, vicinity of Bloody Bay, 31 Aug 1972; USNM 195096-97, St. John

Parish, Roxborough-Parlatuvier Rd, vicinity Bloody Bay, 31 Aug 1972; USNM 195152-55, St. Paul Parish, Windward Rd, vicinity milestone 22 1/2, near Lambeau Hill Crown Trace, 14 Sept 1972; USNM 195156, St. Paul Parish, Windward Rd, vicinity milestone 22 1/2, near Lambeau Hill Crown Trace, 15 Sept 1972; USNM 227732, St. John Parish, Charlotteville-Bloody Bay Rd, mile marker 27 1/2, 17 Nov 1971; USNM 227733-40, St. John Parish, Charlotteville-Bloody Bay Rd, mile marker 27 1/2, 16 Nov 1971; USNM 227742, St. John Parish, Charlotteville-Bloody Bay Rd, mile marker 27 1/2, 16 Nov 1971; USNM 227743, St. John Parish, Hermitage River Bridge, 2 mi WSW Charlotteville, 16 Dec 1978; USNM 227744-45, St. John Parish, Hermitage River Bridge, 2 mi WSW Charlotteville, 23 Aug 1978.

[*Centrolenella orientalis*]

MCZ 72497, Venezuela Estados Sucre-Monagas, Cerro Turimiquire, 1200 m.

Colostethus cf *dunni*

USNM 167506, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity milestone 28 3/4, 5 July 1970; USNM 227746-47, St. John Parish, Speyside, 6 July 1979; USNM 227748-52, St. Paul Parish, 2 mi W Roxborough, 16 July 1979; USNM 227753-4, St. John Parish, Hermitage River Bridge, 2 mi WSW Charlotteville, 16 Dec 1978; USNM 227755, St. John Parish, 1 1/2 mi SW Charlotteville, Northside Rd, milepost 30.9, 16 Dec 1978; USNM 227756-58, St. John Parish, mile post 31.3-31.4 along Northside Rd, 1 1/4 mi SW Charlotteville, 26 Dec 1978; St. John Parish, ca 2 km S Charlotteville, Pigeon Peak Trail, 7 July 1979; USNM 227775, St. John Parish, ca 3 km SW Charlotteville, 11 July 1979; USNM 227776-78, St. John Parish, Charlotteville, 12 July 1979; USNM 227779-83, St. John Parish, Charlotteville-Bloody Bay Rd, mile marker 27.5, 30 March 1979.

[*Colostethus dunni*]

None.

[*Colostethus Trinitatis*]

USNM 141546, Trinidad, near La Veronica, 18 Aug 1953; USNM 141547, Trinidad, nr. Nopinot, 19 Aug 1953; USNM 141548-58, Trinidad, Morne Bleu, 20 Aug 1953; USNM 141559-67, Trinidad, Blue Basin, 23 Aug 1953; USNM 146355, 146359-60, Trinidad, Arima Valley, Spring Hill Estate, 8 Jan 1962; USNM 166302-04, Trinidad, Arima Valley, Spring Hill Estate, 8 Nov 1967; USNM 166305-35, Trinidad, Maracas, Trail to Maracas Falls, 11-12 Nov 1967; USNM 166336, Trinidad, Maracas, Trail to Maracas Falls, 11 Nov 1967; USNM 166337, Trinidad, Maracas, Trail to Maracas Falls,

12 Nov 1967; USNM 166338-42, Trinidad, Mt. El Tucuche, 2500 ft, 15 Nov 1967; USNM 167515, Trinidad, St. George Co., Arima Valley, Simla, 28-29 June 1970; USNM 195160, Trinidad, St. George Co., Arima Ward, Spring Hill Estate, 8 Sept 1972.

Reptiles

Geochelone

None

Rhinoclemmys punctularia punctularia

None

Caretta caretta caretta

None

Gonatodes ocellatus

USNM 167477-80, St. John Parish, Charlotteville, 4, 5, 9 July 1970; USNM 167512, St. John Parish, Bloody Bay-Charlotteville Rd, Milestone 27 3/4, 2 July 1970; USNM 192964, St. John Parish, Charlotteville-Bloody Bay Rd, vicinity milestone 27 3/4, near Hermitage, 12 July 1971; USNM 227856, St. John Parish, Charlotteville, forest above Pirates' Cove, 22 Dec 1978; USNM 227857, St. John Parish, 1 mi SW Charlotteville, Hermitage Rd, 12 March 1979; USNM 227858, St. John Parish, Charlotteville, 28 March 1979; USNM 227859-61, St. John Parish, ca 2 km S Charlotteville, Pigeon Peak Trail, 7 July 1979; USNM 227862, St. John Parish, 5 km W Charlotteville, near Hermitage, 8 July 1979; USNM 227863-65, St. John Parish, ca 3 km SW Charlotteville, 11 July 1979; USNM 227866, St. John Parish, ca 1 3/4 miles SW Charlotteville, along trail to ridge crest, 30 Aug 1980; USNM 227867-69, St. John Parish, Hermitage, 12 March 1979; USNM 227870, St. John Parish, Hermitage, 11 March 1979; USNM 227871, St. John Parish, near Hermitage River Bridge, 14 March 1979; USNM 227873, St. John Parish, Hermitage, 27 May 1979; USNM 227874-75, St. John Parish, Bloody Bay River, ca 1 mile upstream from Bloody Bay, 11 March 1979; USNM 227876, St. Paul Parish, near Roxborough, mile-post 6.4 on Roxborough-Parlatuvier Rd, 17 Dec 1978; USNM 227877, 2.2 miles N, 2.0 miles W Roxborough, 16 July 1979; USNM 227878, St. Paul Province, Merchiston, 23 Dec 1978.

Anolis richardi

USNM 167483-90, St. John Parish, 1, 4, 5, 8 July 1970; USNM 192772, St. John Parish, Charlotteville, 27 July 1971; USNM 195007, St. John Parish, Charlotteville, 30 Aug 1972; USNM 195112, St. John Parish, Charlotteville, 4 Sept 1972; USNM 195133, St. John Parish, Charlotteville, 12

Sept 1972; USNM 195134, St. John Parish, Charlotteville; USNM 227916, St. George Parish, Barbados Bay, 20 Dec 1978; USNM 227917-18, St. John Parish, Charlotteville, 15 Dec 1978; USNM 227919-20, St. John Parish, Charlotteville, 16 Dec 1978; USNM 227921, St. John Parish, Charlotteville, 12 March 1979; USNM 227922-23, St. John Parish, Charlotteville, 6 July 1979; USNM 227924, St. John Parish, Charlotteville, 11 July 1979; USNM 227925, St. John Parish, Charlotteville, 14 July 1979.

Mabuya bistriata

USNM 227931, St. John Parish, Charlotteville, 18 Dec 1978; USNM 227932, St. John Parish, Charlotteville, forest above Pirates' Cove, 22 Dec 1978.

Ameiva ameiva subsp

USNM 167481, St. John Parish, Charlotteville, 5 July 1970; USNM 195008, St. John Parish, Charlotteville, 30 Aug 1972; USNM 195009, St. Paul Parish, Roxborough-Parlatuvier Rd, vicinity milestone 5, 30 Aug 1972; USNM 195072-79, St. John Parish, Charlotteville, 1 Sept 1972; USNM 195080-83, St. John Parish, Charlotteville, 2 Sept 1972; USNM 195084, St. John Parish, Charlotteville, 4 Sept 1972; USNM 195085-90, St. John Parish, Charlotteville, 5 Sept 1972; USNM 195091, St. John Parish, Charlotteville, 6 Sept 1972; USNM 195092, St. John Parish, Charlotteville, 11 Sept 1972; USNM 195093, St. John Parish, Charlotteville, 12 Sept 1972; USNM 195094, St. John Parish, Charlotteville, 13 Sept 1972; USNM 195095, St. John Parish, Charlotteville, 12 Sept 1972; USNM 227933, St. John Parish, Bloody Bay; USNM 227934, St. John Parish, Charlotteville, 17 Dec 1978; USNM 227934, St. John Parish, Charlotteville, 18 Dec 1978; USNM 227937, St. John Parish, Charlotteville, date unknown; USNM 227938, St. John Parish, Charlotteville, 27 Aug 1980; USNM 227941, St. Mary Province, 1/2 mile W Goldsborough River, Windward Rd, 29 June 1979.

[*Ameiva ameiva atrigularis*]

USNM 17731-4, Trinidad, 1891; USNM 120777, Trinidad, 1879; USNM 166635-39, Trinidad, Maracas, 14-15 Nov 1967.

[*Ameiva ameiva tobagana*]

USNM 10113, Grenada (originally recorded as Tobago), no date; USNM 43222-23, Grenada, St. George, 16 Sept 1900; USNM 79111, Grenadines, Petit Mustique, 18 Aug 1929; USNM 79147-49, Grenadines, Frigate, 22 Aug 1929; USNM 79194-95, Grenada, Mineral Springs, Aug 1929; USNM 104198-99, Grenadines, Bequia, March 1937; USNM 104200-01,

Grenadines, Mayreau, April, 1937; USNM 104202, Grenadines, Union, April, 1937.

Bachia cf *flavescens*

USNM 227942, St. Mary Parish, near Hillsborough Dam, 21 Dec 1978; USNM 227943, St. Mary Parish, Hillsborough Lake, July 1979; USNM 227944, Hillsborough Dam, east side of lake, 17 April 1979.

[*Bachia flavescens*]

BMNH 2930.10.10.167, Guyana, Moraballi, on Rio Essequibo River, 28 Aug 1929; RMNH 3580, no locality or date; UMMZ 65170, Guyana, Kartabo, no date.

Gymnophthalmus underwoodi

None.

Tupinambis nigropunctatus

USNM 228012, St. John Parish, Charlotteville, 17 March 1979.

Typhlops trinitatis

USNM 228131, St. Paul Parish, Roxborough-Parlatuvier Rd, milepost 6.4, 17 Dec 1978; USNM 228132, St. Paul Parish, near King's Bay, dam on King's Bay River, 14 May 1979; USNM 228133, St. John Parish, Charlotteville, forest above Pirates' Cove, 15 Dec 1978; USNM 228134, St. John Parish, ca 2 km S Charlotteville, Pigeon Peak Trail, 7 July 1979; USNM 228134, St. Paul Parish, Merchiston, 23 Dec 1978; USNM 228136, St. Mary Parish, Hillsborough Dam, east side of lake, 25 July 1979; USNM 228137, St. Mary Parish, Hillsborough Dam, 25 Aug 1980.

Leptotyphlops tenella

None.

Corallus enydris cooki

USNM 228017-19, St. Mary Province, Lake above Hillsborough Dam, 18 June 1979; USNM 228020, St. John Parish, ca 5 km W Charlotteville, near Hermitage, 8 July 1979.

[*Corallus enydris cooki*]

USNM 67233, Grenada, March 1924; USNM 167398, Grenada, St. George Parish, Annandale, 10 June 1969.

Attractus cf *univittatus*

USNM 228024, St. John Parish, along Main Ridge, ca 1 1/4 mi SSW Charlotteville, 27 Dec 1978.

[*Atractus univittatus*]

None

Clelia clelia clelia

None

Erythrolamprus ocellatus

USNM 195111, St. Paul Parish, intersection of Windward Rd and Merchiston Rd, 4 Sept 1972; USNM 228050, St. Paul Parish, near Merchiston, 10 May 1979; USNM 228051, St. John Parish, Windward Rd, ca 1 mi S Charlotteville, 17 Dec 1978; USNM 228052, St. John Parish, ca 1/4 mi S Charlotteville on Windward Rd, 19 July 1979; USNM 228053, St. John Parish, Charlotteville, 18 May 1979; USNM 228054, St. John Parish, 1/2 mi SW Speyside on Windward Rd, 23 Dec 1978; USNM 228055, St. John Parish, in forest above Speyside, 8 July 1979; USNM 228056, St. John Parish, Cambleton (near Charlotteville), 27 June 1979; USNM 228057, St. John Parish, Charlotteville, 20 Aug 1979; USNM 228058, St. George Parish, ca 1 mi from Hillsborough Dam on Easterfield Rd, 29 June 1979.

[*Erythrolamprus "aesculapii"*]

RVIM 112, Trinidad, Diego Martin, 10 Nov 1941.

Liophis cobella

None

Liophis sp

USNM 228069, St. John Parish, creek crossing Pigeon Peak Trail, ca

1500 feet, 12 May 1979.

[*Liophis reginae*]

USNM 17757, Trinidad, 1891.

[*Liophis zweifeli*]

USNM 196332, Venezuela, Miranda St., near Caracas, 25 Nov 1967.

Oxybelis fulgidos

None.

Oxyrhopus petola petola

USNM 228112, St. Paul Parish, Lambeau Hill, near Merchiston, 21 May 1979.

Spilotes pullatus pullatui

USNM 228122, St. John Parish, Speyside, 14 July 1979; USNM 228123, St. Mary Province, Hillsborough Dam, ca 1/2 mi downstream from dam; USNM 228124, St. John Parish, Windward Rd, between Speyside and Charlotteville, 28 June 1979; USNM 228125, St. John Parish, ca 2 mi SW Charlotteville on Hermitage Rd, 8 July 1979; USNM 228126, St. John ca 3 km SW Charlotteville, 11 July 1979; USNM 228127, St. John Parish, Charlotteville, 19 Dec 1978.

[*Spilotes pullatus pullatus*]

USNM 39064, Brazil, Sao Paulo (date unknown); USNM 71145, Brazil, Sao Paulo, 1925-26; USNM 132896, Venezuela, Caracas, 25 May 1952; USNM 193748, Peru, Departamento Huanuco, Rio Huallago, 28 Feb 1968.

Caiman crocodilus

USNM 228138. St. Mary Parish, Windward Rd, Goldsborough River Bridge, 16 March 1979.

Mammals

Oryzomys sp.

USNM 538101, St. John Parish, summit of Piegon Peak, 12 Aug, 1979; J. D. Hardy, collector.

Nectomys squamipes

USNM 537966, St. John Parish, Bloody Bay, 9 July 1979, collector unknown.

Tayassu tajaca

USNM 538074, St. Paul or St. John Parish, killed by local hunter in forest N Roxborough-Bloody Bay Rd, 4 Aug 1979; J. D. Hardy, collector.

Procyon cancrivorus

USNM 00538073, St. Paul or St. John Parish, hilled by local hunter in forest N Roxborough-Bloody Bay Rd, 4 Aug 1979; J. D. Hardy, collector.

Sturnira lilium

USNM 00538023-63, St. John Parish, various localities, July, 1979; Gary Morgan, collector.

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Failure of Orientation to Frog Calls by Migrating Spotted Salamanders

Don C. Forester and Daniel La Pasha

Abstract

Controlled field experiments were conducted to determine the importance of audition to spotted salamanders during their migration toward the reproductive site. Adult salamanders were presented amplified tape recordings of frog calls. The behavioral response of experimental groups did not differ from that of controls.

Although closely related to anurans, the majority of urodele amphibians are mute. Nevertheless, the existence of vocal cords has been documented in ambystomatids (Maslin, 1950), and a few species emit faint squeaks, whistles or clicks (Geyer, 1927; Noble, 1931; Maslin, 1950; Meyers, 1951; Neill, 1952; Gehlbach and Walker, 1970; Wyman and Thrall, 1972). Noble (1931) considered all urodeles to be deaf. The first to challenge this concept experimentally was Ferhat-Akat (1939) who demonstrated by classical conditioning that the axolotl (*Ambystoma sp.*) can be trained to respond to frequencies as high as 244 Hz, and that larval newts (*Salamandra salamandra*) will respond to frequencies up to 1,035 Hz. More recently, E. G. Wever of the Auditory Research Laboratory, Princeton University, has employed electrophysiological techniques to confirm auditory sensitivity in salamander species representing several families (pers. comm.).

Several investigators have suggested that salamander vocalizations may play a role in social communication (Geyer, 1927; Maslin, 1950; Gehlbach and Walker, 1970; Wymann and Thrall, 1972), but only Gehlbach and Walker provided behavioral data to support their hypothesis. In his morphological comparison of the inner ear of salamanders, Lombard (1977) conceded that urodeles probably perceive low frequency sounds of moderate intensity. However, since most salamanders are relatively small and there is, among anurans, an inverse correlation between body size and dominant frequency (Loftus-Hills and Johnstone, 1969), he doubted that many species could produce audible sounds in the frequency range necessary for intraspecific communication. As an alternative hypothesis, Lombard suggested urodele audition may serve to monitor environmental sounds. In the present investigation we test the ability of spotted salamanders (*Ambystoma maculatum*) to utilize auditory cues to locate a reproductive site.

Seasonal movements to the reproductive site by spotted salamanders commence during late February to mid-March in Maryland, and coincide with snow melt and the onset of early spring rains. Although many individuals overwinter on wooded slopes adjacent to the reproductive sites, others move to ponds from distances greater than .5 km (pers. observ.). The primary sensory system used by this terrestrial species during its annual migrations is, as yet, unclear. However, olfaction has been demonstrated to be of paramount importance to salamandrids (Twitty, 1961; Hershey and Forester, 1980) and may be implicated for spotted salamanders (Forester, unpubl.).

In Maryland, the spotted salamander breeds in the same place, synchronously with the woodfrog (*Rana sylvatica*) and the spring peeper (*Hyla crucifer*). At our study site, males of both anuran species reach the breeding ponds in advance of the salamanders and begin vocalizing. We hypothesized that auditory cues produced by the frogs may provide migrating salamanders with directional information.

MATERIALS AND METHODS

Study site. -- The breeding site used by the frogs and salamanders described in this study is an emphemeral, woodland pond located 24 km N of Towson, Maryland. The pond is approximately 203 m long and 21 m wide. It is bordered on the N by a steep (38-42°), wooded (Beech-Maple) hillside and on the S by the Gunpowder Falls River. A drift fence was located between the pond and the base of the hill, enabling us to capture the majority of the frogs and salamanders attempting to enter or leave the pond. The fence, constructed of hardware cloth (3.18 mm), was 150 m long and 30 cm high. A screen baffle was affixed to the top of the fence to prevent animals from crawling over. Pit-fall traps (4-1 jars) were sunk at 3 m intervals along the base of the fence on both sides.

Sound recordings and measurements. -- A mixed chorus of wood frogs and spring peepers was recorded using an omni-directional microphone (Sony EMC-33P) and a battery powered tape recorder (Uher Report 4000). The microphone was hand-held 10 m from the edge of the pond, at a point equidistant from the two ends. In addition, recordings were made of individual males of both species. To ascertain species specific sound properties, the individual calls were analyzed on a sound spectrograph (Kay Spectrum Analyzer 6061B). Following narrow band spectrographic analysis, individual calls were sectioned to determine their energy composition for each harmonic frequency.

Sound intensities were measured with a sound level meter (General Radio 1551C) at the recording sites as well as at selected points on the hillside above the pond. The measurements enabled us to document the potential sound energy available to migrating salamanders at various distances from the pond. Sound pressure measurements were made along three transects between the N edge of the pond and the crest of the hill (Table 1). Each station on the crest of the hill was approximately

TABLE 1. Field dB readings made at selected points on the hill adjacent to the study pond.

			RECORDING STATIONS		
TRANSECT		POND EDGE	10 m	70 m (mid-hill)	140 m (hill crest)
NE END	Base	-	68	58	52
	Peak	-	72	60	54
CENTER	Base	78	70	60	58
	Peak	86	76	64	60
NW END	Base	-	52	52	52
	Peak	-	54	52	52

145 m from the N edge and 90 m from the surface of the pond. All values were measured at 10 cm above the surface with C weighting and with the sound pressure meter on the standard "fast" setting. Due to the relatively long meter-time-constant of our instrument, it is likely that the peak values are conservative.

Field tests. -- Three hundred and forty-two adult salamanders were collected from the drift fence over a six-day period and transported to a test site 4 km to the SSW and well outside the auditory range of the home pond. Auditory orientation experiments were conducted in a circular test arena (D-20 m) constructed of hardware cloth (6.35 mm), 30 cm high. An 8 cm baffle was affixed to the top of the arena wall and pit-fall traps (4-1 jars) were buried flush with the inner base of the fence at 15° intervals. The test arena was situated in a deciduous woodlot. Its floor was generally level (>3°) and covered with leaf litter and decomposing logs. A level, circular platform and holding cage (D-1 m) were positioned in the center of the arena and a release cable extended beyond the test site.

The salamanders were divided into four experimental and three control groups (n=42-62). Each group was placed in the holding cage and allowed 45 min to recover from the effects of handling prior to release. During experimental trials, a tapeloop, constructed from a recording of the home pond chorus, was amplified and played through a midrange speaker (D-20.32 cm) which was placed at a preselected position at the perimeter of the arena. The sound level of the recording was adjusted to correspond with natural intensities. The broadcast commenced 30 min after the animals had been placed in the cage and 15 min prior to their release. During three experimental trials, the speaker was positioned at a point corresponding to N, while during a fourth trial, it was positioned at a point corresponding to S. The recording was not played during control trials.

Upon release from the cage, salamanders were allowed to move to the edge of the arena where they would fall into the pit-fall trap corresponding to their direction of movement. During a trial, orientation and movements were monitored with an infrared spotting scope (Find-R-Scope). Trials usually commenced at 2100 h on rainy nights and were allowed to run until dawn.

Data analysis: -- The null hypothesis of our experiments was that salamanders would orient randomly in the arenas (at the 5% level of confidence). The Rayleigh test (test statistic z; Zar, 1974) for circular distribution was used to support or reject a directional tendency. For our experiments, the expected direction was toward the sound source.

RESULTS AND DISCUSSION

Sound recordings and measurements. -- Narrowband, spectrographic analysis of spring peeper calls from our study population reveal that each call is composed of a single, repeated note containing six variously distinct harmonics. Most of the energy is concentrated above 1300 Hz and the dominant frequency ranges from 2500 to 3000 Hz (Fig. 1a). In contrast, the call of the wood frog is complex. It is composed of a lead component which exhibits harmonic structure and is followed by two distinct pulses. The initial component contains energy between 500 and 3000 Hz while the pulse components contain continuous energy from 100 to 8000 Hz (Fig. 1b). The full auditory potential of these calls to salamanders is best appreciated by examination of a narrowband spectrogram depicting a mixed chorus of the two species (Fig. 1c) coupled with a spectrographic section taken at a random point in the chorus (Fig. 1d); a section plots sound intensity (loudness) against frequency (Hz). While the collective calls of both anuran species fall within the 50-5000 Hz cochlear sensitivity for the spotted salamander, the woodfrog has the greatest energy concentrated near the salamanders' sensitivity peak -- 500 Hz (frequency values provided by E. G. Wever, pers. comm.).

Although there was a decrease in sound intensity as we proceeded up the hill and away from the pond, our values did not correspond to the inverse square law (Table 1; cf. Gerhardt, 1975). Measurements from the NW end of the pond were low and uniform due to the spatial concentration of the chorus in the eastern one half of the pond. In contrast, intensity measurements along the other transects were higher than predicted at both the mid-point and crest of the hill. The failure of sound levels to attenuate as predicted may be due to the slope of the hill or the relatively low carrier frequency of the chorus (low frequency sounds are composed of long wavelengths that are less prone to absorption by vegetation and other environmental obstacles, Fig. 1d). Griffin and Hopkins (1974) and Griffin (1976) reported that the sound level of frog choruses fell off with altitude much more slowly than one would expect. At our study site, sound may have reached the mid- and upper slope by passing relatively unobstructed from the pond surface.

The anuran chorus was clearly audible and readily distinguishable from background noise at all three hilltop stations. A spectrographic section of recordings made at the crest of the hill indicates significant energy in the biologically critical frequency range (Fig. 1d-e), but it is now known how much of this acoustical energy may have resulted from low frequency abiotic sounds such as rainfall or the flowing water in the nearby Gunpowder Falls River.

Field trials. -- In all seven trials, the orientation of the salamanders was random (Fig. 2). These data suggest that if anuran choruses possess sufficient acoustical energy in the biologically critical range, the information is not utilized by spotted salamanders during their orientation to the reproductive site. Our experiments

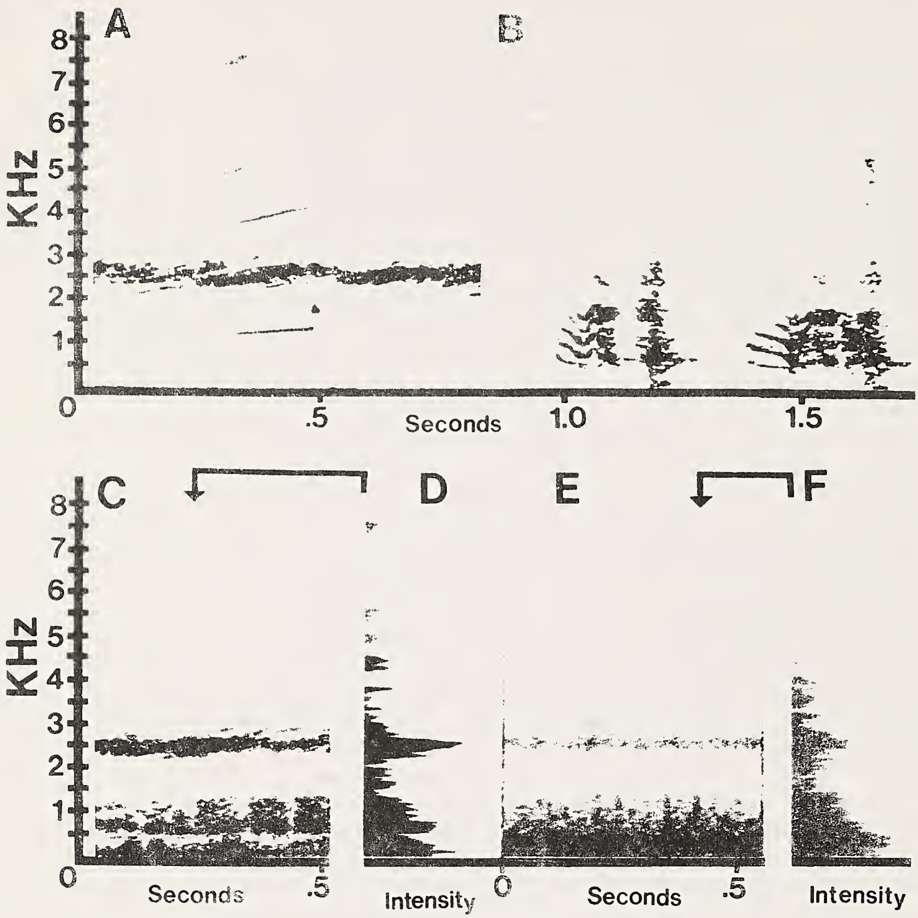
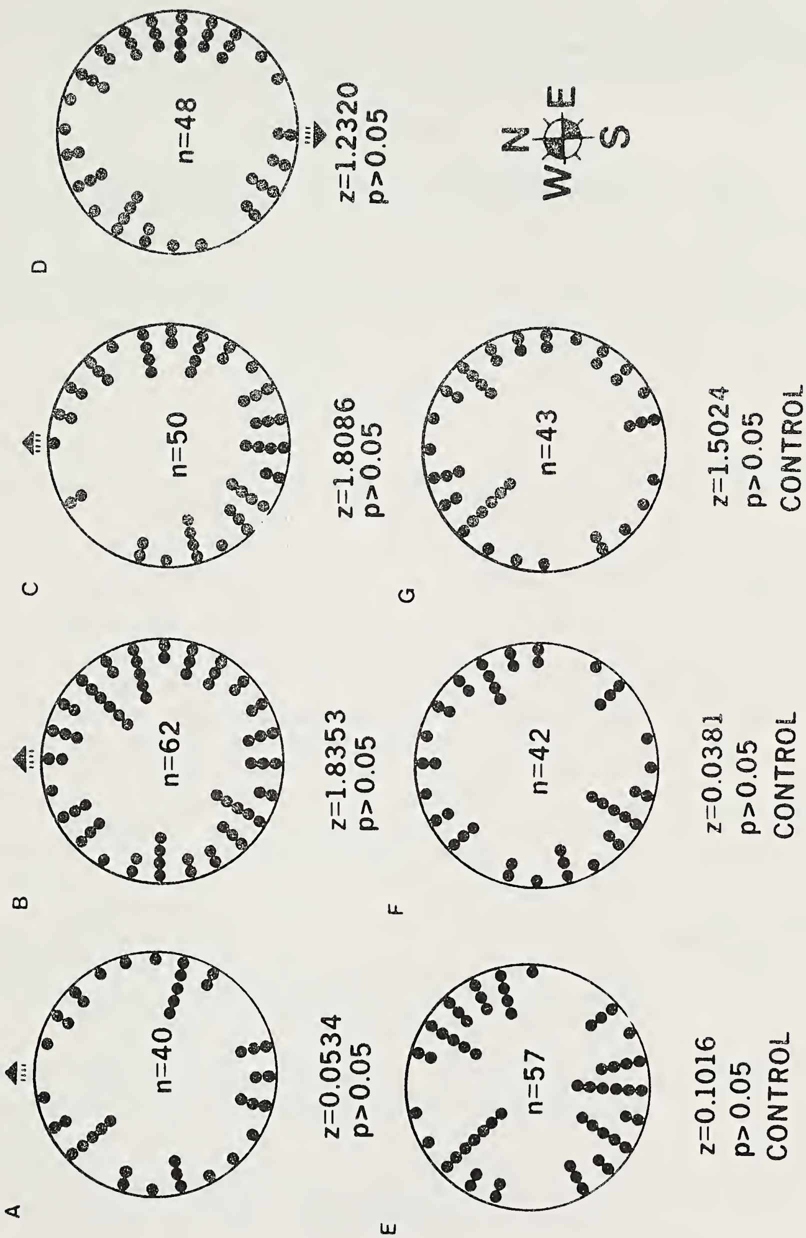


Figure 1. Sound spectrograms of (A) *Hyla crucifer*, (B) *Rana sylvatica*, (C) a mixed chorus of the two species recorded at pondside and (D) a similar recording of the chorus made from the crest of the hill, 90 m above the pond. Spectrographic sections (D and F) were made from (C) and (E) respectively at points indicated by the arrows.


A
n=40
z=0.0534
p>0.05
B
n=62
z=1.8353
p>0.05
C
n=50
z=1.8086
p>0.05
D
n=48
z=1.2320
p>0.05
E
n=57
z=0.1016
p>0.05
CONTROL
F
n=42
z=0.0381
p>0.05
CONTROL
G
n=43
z=1.5024
p>0.05
CONTROL
N
W
E
S

test the importance of only one category of environmental sounds to a single species. Nevertheless, based on our results, we doubt that audition if of significance to any terrestrial urodele, and thus we recommend rejection of the auditory hypothesis.

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STRIKE-INDUCED CHEMOSENSORY SEARCHING BY PRAIRIE RATTLESNAKES *(Crotalus v. viridis)* AFTER PREDATORY AND DEFENSIVE STRIKES WHICH MADE CONTACT WITH MICE *(Mus musculus)*

Barbara O'Connell, Thomas Poole, Paul Nelson, Hobart M. Smith, and David Chiszar

Abstract

Nine prairie rattlesnakes (*Crotalus viridis*) each struck two mice (*Mus musculus*, 15-25 gm). In one case normal predatory strikes were delivered; in the second case the snakes were first induced to adopt defensive postures and the strikes were presumably defensive strikes. Both kinds of strikes resulted in a sustained, high rate of tongue flicking (a phenomenon called strike-induced chemosensory searching), although the rate of tongue flicking was higher after predatory than after defensive strikes. Nonetheless, these data clearly indicate that food-seeking behaviors can be released in defensively aroused rattlesnakes if they can be induced to strike a mouse (even for defensive reasons). Mice that received defensive strikes experienced the same severity of envenomation as mice that received predatory strikes.

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Many experiments have shown that striking rodent prey results in a sustained, high rate of tongue flicking (RTF) in rattlesnakes (see Chiszar & Scudder, 1980, and Chiszar et al., 1982a, for reviews). This phenomenon has been called strike-induced chemosensory searching (SICS: Chiszar, et al., 1977). Since rattlesnakes typically release adult rodents after striking (Gans, 1966; O'Connell et al., 1982; Radcliffe et al., 1980), and since an envenomated rodent can wander up to 600 cm from the site of attack before succumbing to venom (Estep et al., 1981), the task of locating the dead prey is nontrivial. This task is facilitated by SICS (Dullemeijer, 1961; Golan et al., 1982), although rattlesnake attentiveness to prey-derived chemical cues can be induced in the absence of an opportunity to strike prey by other factors such as hunger, visual-thermal cues arising from rodents, and odors from putrid carrion (Chiszar et al., 1981b,c; Cowles & Phelan, 1958; Gillingham & Baker, 1981; Gillingham & Clark, 1981). Nevertheless, striking prey seems to exert the strongest and most reliable effect on RTF, and, hence, on sensitivity to rodent chemical cues.

Viperid snakes which have consistently refused to eat in captivity can often be induced to do so if a prey-contacting strike can be elicited, even for defensive reasons. Hence, it has been hypothesized that stimulation arising from oral contact with prey (as opposed to stimulation that motivated the strike) is the critical factor in the induction

of feeding behavior. Scudder (1982) has shown that at least two kinds of strike-derived stimulation contribute to SICS as well as to other aspects of the predatory reaction chain: proprioception and chemical stimulation of the vomeronasal receptors. The latter is probably most important (Burghardt, 1970; Kubie, 1977), and may explain why defensively motivated strikes which contact mice are able to induce feeding behavior. Such strikes will result in acquisition of rodent molecules by the vomeronasal receptors and will, therefore, provide a trigger for subsequent aspects of the predatory reaction chain, even in nervous snakes (Chiszar et al., 1980, 1982b). Hence, it can be predicted that such strikes should cause SICS; and, the present study provides a test of this prediction.

This experiment was designed to elicit defensive strikes aimed at a simulated human hand, but to permit the snake to bite a mouse (which was substituted for the simulated hand at the last instant). We sought to answer two questions: (1) Would SICS occur after these presumably defensive strikes, and (2) would the magnitude of SICS in this situation be comparable to SICS seen in a normal predatory situation? Also, we measured survival time of mice struck in the predatory and defensive contexts to determine whether severity of envenomation differed as a function of the motivation behind the strike.

Methods and Materials

Subjects. -- Nine adult prairie rattlesnakes were observed. All had been in captivity and had been accepting rodent (*Mus musculus;* 15-25 gm) prey on a weekly feeding schedule for at least one year prior to this study. Daily photophase began at 0700 and ended at 1900, and temperature was kept at 26$\pm$1°C (Klauber, 1956) by electric heaters. During scotophase temperature dropped to 23$\pm$1°C. Snakes were individually caged in glass terraria (62x32x32 cm) containing paper floor coverings and glass vessels filled with water.

Procedure. -- Each snake was observed in two conditions. In the predatory condition (PC) a mouse (*M. musculus;* 15-25 gm) was suspended via long forceps into the cage and held out of striking range for 3 sec. Then the mouse was moved into range, the snakes always struck immediately, and the mouse was removed after being released by the snake (snakes always released the mice in less than .5 sec after the strike). In the defensive condition (DC), a clean plastic glove (stuffed with cotton, warmed to human body temp, and attached to a 50 cm dowel) was inserted into the cage, held out of striking range, and waved for 3 sec. This elicited defensive coiling, rattling, and other ritualized defensive behaviors (Gove, 1979; Klauber, 1956). A live mouse was carefully concealed behind the glove, and at the end of the 3 sec presentation the assembly was moved into range and rotated to expose the mouse just as the snake launched its (presumably) defensive strike. The assembly was removed immediately after the snake released the mouse. Although we cannot be absolutely certain that the snake was unaware of the mouse

until striking it, we are quite certain that DC elicited far more defensiveness than PC (which elicited no defensive behavior; see Iglehardt & Chiszar, 1977).

All tongue flicks emitted by each snake were recorded beginning 5 min prior to PC and DC (baseline observations) and continuing for 25 min following the strikes. Tongue flicks were recorded with hand-held counters (see Chiszar et al., 1981a, for statistics on inter-observer agreement in recording tongue flicks).

Snakes were exposed to conditions at the rate of one per week (prior to feeding); 5 snakes received PC the first week and DC the second, whereas the remaining 4 snakes received the reverse order of presentation.

Mice were placed into a large wooden box (100 x 100 x 90 cm) immediately after being struck. The floor of the box was marked off into 36 16.5-cm squares. We recorded: (1) the number of sec before the mouse became immobile, (2) the number of squares traversed (and, hence, distance traveled prior to immobilization), and (3) number of sec before the mouse died (defined as complete cessation of visible respiratory contractions).

Results

Mean RTF is plotted over successive min in Figure 1 for PC and DC, and it is obvious that both conditions produced RTF elevations above baseline (comparing min 1-5 with 6-10 gave $F = 21.68$, $df = 1/8$, $p < .01$) We have also plotted data from another study (O'Connell & Chiszar, 1981) in which prairie rattlesnakes were exposed to PC and DC treatments identical to those of the present study, except that no strikes were permitted. It is clear that the present PC and DC treatments produced higher RTF's than the no-strike versions. Accordingly, we conclude that SICS occurred in both of the present conditions. However, the difference between the present PC and DC treatments indicate that the magnitude of SICS was reduced in DC relative to PC. Specifically, RTF increased to a greater extent above baseline during min 6-10 in PC than in DC ($F = 5.49$, $df = 4/32$, $P < .01$).

The data on mouse survival time and movement are shown in Table 1. Most important is the fact that no measure differed significantly between PC and DC. Eight mice in both PC and DC died within 500 sec of being struck; one mouse in each condition did not die within 30 min (at which time observation was discontinued; we conclude that these bites were either misses or "dry bites"). Accordingly, mice struck in PC or in DC were probably treated equally by the rattlesnakes (i.e., the severity of envenomation was equal).

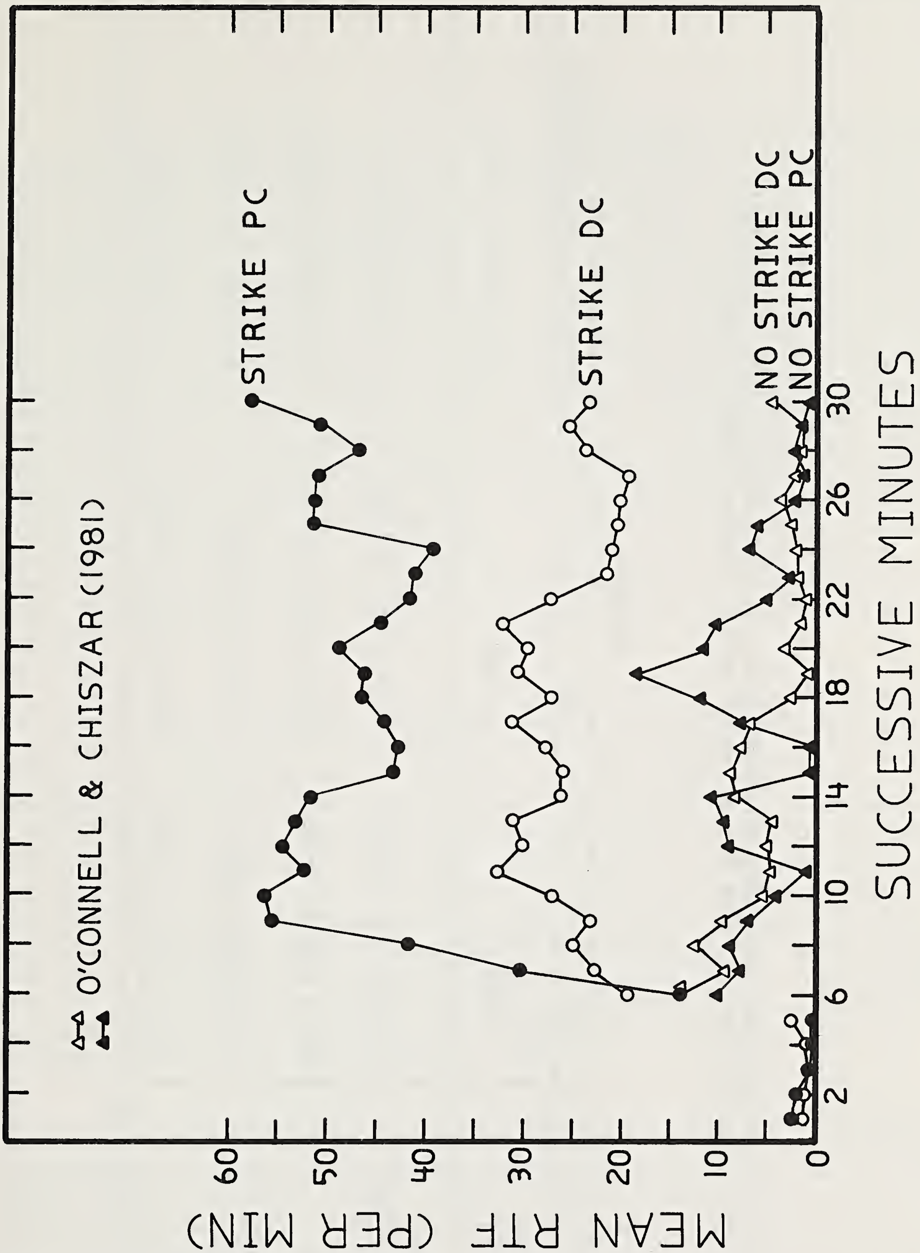

Figure 1. Mean number of tongue flicks plotted over 30 min. During min 1-5 the snakes were undisturbed. Then snakes were exposed to the predatory condition and allowed to strike a mouse (STRIKE PC) or to the defensive condition and allowed to strike a mouse (STRIKE DC). For comparison, two curves from a study reported by O'Connell and Chiszar (1981) are also plotted. These curves were derived from prairie rattlesnakes exposed to conditions identical to PC and DC, except that no strikes were permitted.

Table I. Data from mice that died after being struck in PC and DC. Mean (SD; range) time to immobilization, time to die, and distance traveled after envenomation

	Condition		
Measure	PC	DC	Outcome of Statistical Test
Number mice that died after being struck (%)	8 (89%)	8 (89%)	sign test, $P > .05$
Mean number of sec to immobilization (SD; Range)	53.6 (56.0; 1-180)	46.0 (45.8; 6-150)	$t = 0.23$, $P > .05$
Mean number of sec to die (SD; Range)	161.5 (186.5; 5-490)	172.2 (131.6; 40-420)	$t = 0.82$, $P > .05$
Mean number of squares traversed (SD; Range)	8.2 (8.9; 0-24)	5.4 (7.7; 0-23)	$t = 0.67$, $P > .05$
Mean number of cm traversed (SD; Range)	136.1 (147.2; 0-396)	88.6 (127.7; 0-380)	$t = 0.67$, $P > .05$

Discussion

While it may very well be true that rattlesnakes deliver a higher proportion of "dry bites" during defensive strikes at humans than during predatory strikes at rodents (Klauber, 1956; Reid, 1964; Russell, 1980), defensive strikes at rodents appear to result in lethal envenomation with the same probability as predatory strikes. Two hypotheses can be advanced on the basis of this data: (1) Strikes in DC were really predatory strikes because the snakes may have been aware that they were actually striking mice; and (2) A strike (even a purely defensive one) that contacts a rodent results in release of venom (and SICS) because of stimulation (chemical, tactile, thermal, and/or proprioceptive) arising during the snake's contact with the mouse. The first hypothesis emphasizes the snake's detection of the mouse prior to launching the strike (i.e., pre-strike cues); the second hypothesis does not require prior detection of the rodent target (i.e., post-strike cues or cues encountered during the strike are proposed as determinants of envenomation and SICS). The present data do not permit a decision between these hypotheses because we cannot be certain that the snakes were unaware of mice prior to the strike in DC. Hence, both pre-strike and post-strike cues could have contributed to the results in DC.

One way to assess the relative contributions of pre-strike and post-strike cues to the envenomation process and to SICS is to eliminate the pre-strike cues by eliminating snake vision, thermoreception, and olfaction. If strikes can be elicited in such snakes (presumably only poorly-directed defensive strikes could be launched by such snakes), and if striking a rodent results in envenomation (and SICS), then it would be clear that post-strike cues can control both envenomation and searching behavior. Another test could be conducted by allowing snakes to detect mice prior to striking, but to permit strikes to contact nonprey objects. If venom injection and SICS do not occur after such strikes, then again a role for post-strike cues would be indicated. At present, we have some data which support the idea that post-strike cues are relatively more important (at least for SICS) than pre-strike cues (O'Connell & Chiszar, 1981; Scudder, 1982).

That SICS was reduced in magnitude in DC relative to PC probably reflects competition between defensive behavior elicited by the glove and searching behavior elicited by striking the mouse (Chiszar et al., 1981a, 1982b; O'Connell et al., 1981). Since some aspects of the rattlesnake defensive ritual are incompatible with vigorous searching, it is understandable that SICS was reduced in DC. We believe the important finding is the fact that SICS occurred to any extend in DC; this clearly indicates that a defensively aroused rattlesnake can be induced to exhibit food-seeking responses by pre- or post-contact cues associated with the act of striking a prey item.

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DISTRIBUTIONAL RECORDS FOR MARYLAND HERPETOFAUNA, II

Distributional records and comments on Maryland amphibians and reptiles are given below. Specimens mentioned are in the following collections: National Museum of Natural History (USNM), Natural History Society of Maryland (NHSM), Towson State University (TSU). BZ refers to the former Baltimore Zoo collection (now NHSM); JAF refers to the collection of James A. Fowler, which will eventually be deposited at the Carnegie Museum of Natural History.

Gyrinophilus porphyriticus. Platania (1976), following Harris (1975), reported what he assumed to be the first record of this salamander in the interior of the Valley and Ridge Physiographic Province of Maryland. Fowler (1944), however, provided the first such record by collecting two adults and one nearly metamorphosed individual from a spring tributary to Murley Branch, near Flintstone, Allegany County. These were taken on 7 April 1944 and are catalogued JAF 879 (J. A. Fowler, pers. comm.).

Hemidactylium scutatum. Several additional localities for Carroll County have been obtained by the writer since the initial record reported by Miller (1980). All were nesting females: 3.7 km NW Eldersburg, 10 April 1981 (TSU 4016); 1.3 km SW Bird Hill, 16 April 1981 (TSU 4029-4030); 4.3 km E Sykesville, 20 April 1981 (TSU 4042); near Marriottsville (Howard County), 20, 27 April 1981 (TSU 4048, 4099); 2.0 km E Louisville, 14 May 1981 (TSU 4193-4194). Another nesting female was found 1.7 km ENE Dorsey Crossroads on 10 April 1981, but not collected.

Bufo woodhousei (TSU 4302-4306). Five juvenile specimens were collected along the towpath of the Chesapeake and Ohio Canal at Ford Avenue, Cumberland, Allegany County, on 14 August 1981 by E. L. Thompson and the writer. They currently represent the westernmost locality for the species in the state, and extend this toad's range to close proximity of the Allegheny Plateau, upon which *B. woodhousei* has not been convincingly recorded (Harris 1975; Miller 1980).

Acris crepitans (USNM 104407-104408). These specimens were collected near Flintstone, Allegany County, by R. H. McCauley, Jr. on 6 July 1937. Previously plotted records (Harris 1975) for the Valley and Ridge Physiographic Province, of which most of Allegany County is a part, have been in the Chesapeake and Ohio Canal-Potomac River area.

Gastrophryne carolinensis. Two unreported localities for this toad in St. Mary's County were found in the National Museum collection. USNM 158918 is from Piney Point and was collected on 4 July 1965. USNM 163606-163607 are from Valley Lee and were taken on 9 July 1964. The two previous records for the county were provided by Fowler and Stine (1953) and Miller (1980). *G. carolinensis* is currently considered endangered in Maryland (Committee . . . 1973).

Rana sylvatica. Van Deusen and Johnson (1979), following Harris (1975), stated that the wood frog had been recorded from all Maryland counties with the exceptions of Dorchester and St. Mary's, and reported what they believed to be a first record for the species in Dorchester County (Vienna). However, Mansueti (1940) listed *R. sylvatica* from Cambridge, Dorchester County, and Miller (1979) noted specimens from northern St. Mary's County.

Caretta caretta. This sea turtle has not been recorded from Anne Arundel and St. Mary's Counties (Harris 1975). The National Museum has two specimens from Anne Arundel County: USNM 129257 from Fairhaven Beach, collected on 24 November 1949, and USNM 212329 from Herring Bay, collected on 25 September 1977. The St. Mary's County specimen is USNM 220891 from Patuxent Naval Air Test Center, near Lexington Park, taken on 12 June 1974. All three turtles are represented by skeletal material.

Eumeces laticeps (NHSM/HSH-RSS RL 323). This specimen in the Harris-Simmons collection represents the only record for the species in Harford County. It was taken at Joppatowne in August 1970 from an unspecified railroad trestle, presumably either the Baltimore and Ohio Railroad bridge at the Little Gunpowder Falls, or the Penn-Central Railroad (now Amtrak) bridge at the Gunpowder River. These railroads roughly parallel each other in this area and more or less define the northern and southern limits of Joppatowne. The two trestles are 4.25 km apart.

Lampropeltis calligaster (USNM 141426). This juvenile specimen was collected at Annapolis Junction, Howard County, on 27 September 1936 by R. H. McCauley, Jr. and oddly was not included in his book on the reptiles of Maryland (1945). Only one other specimen, NHSM/HSH-RSS RS 650, is known from Howard County, and was collected ca. 1.5 miles (0.9 km) SW Jonestown, on 22 June 1969 by H. S. Harris, Jr. (plotted in Harris 1975).

Lampropeltis triangulum (NHSM R 2551; formerly BZ 248). This specimen was erroneously listed as *Lampropeltis getulus* by Dyrkacz (1981), and said to be from near Norrisville, "Hartford" County, collected on 9 September 1958. Correct data for the specimen are ca. 5.0 km E Norrisville, Harford County, collected on 22 September 1958. *L. getulus* probably does not occur in the vicinity of Norrisville. The only report of this species in the piedmont of Harford County is an individual found at 618 Old Fallston Road, Fallston (F. P. Ward pers. comm. to H. S. Harris, Jr.; plotted in Harris 1975).

Storeria occipitomaculata (USNM 139585). This specimen is from the National Agricultural Research Center, Beltsville, Prince George's County, and was collected in March 1943 by J. A. Fowler. More specifically, it was taken "in the near environs of the Zoological Division of the Bureau of Animal Industry" (J. A. Fowler, pers. comm.). The species has not previously been recorded from the county (Harris 1975). At one

time another red-bellied snake from Prince George's County was present in the National Museum collection (USNM 124274 from Greenbelt, taken on 5 May 1947), but this specimen has been missing for at least ten years (R. I. Crombie, pers. comm.).

Thamnophis sirtalis. Grogan (1981) reported the first record of this species in Wicomico County (Parsonsburg), and noted that it was "very common" in the vicinity of Salisbury, although no other specific localities were mentioned. On 5 October 1981 the writer found a DOR *T. sirtalis* on U.S. Route 50, 0.8 km W JCT U.S. Route 50 and Friendship Road, 1.0 km S Pittsville, at 1030 hours. Two more DORs were found on Sheppard's Crossing Road, 0.15 km E JCT Sheppard's Crossing Road and Bethel Road, Twilley, at 1200 hours. While all three snakes were fairly fresh, none were worth saving.

Crotalus horridus (USNM 139618). On the basis of a 1974 photograph in a Frederick County newspaper, Harris (1975) plotted a record for *C. horridus* from Sugarloaf Mountain, Stronghold, Frederick County. A specimen, however, does exist for this locality and was collected on 4 August 1946 by J. A. Fowler. The snake was taken at the overlook on the summit of the mountain (J. A. Fowler, pers. comm.). The site is of significance since Sugarloaf Mountain is an outlier of the Catoctin Mountain chain (Blue Ridge Physiographic Province), and the rattlesnakes occurring there may well be disjunct from other Maryland populations.

I thank Edward L. Thompson for field assistance, and Ronald I. Crombie and James A. Fowler for providing information.

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A BRIEF NOTE ON AN UNUSUAL BREEDING OCCURRENCE IN THE AMERICAN TOAD, *BUFO A. AMERICANUS*

On 18 April 1981, between 7-8:00 p.m. (EST), James Jarrett and I were driving north on Loch Raven Drive, Baltimore County, Maryland, when we observed thousands of American toads, *Bufo a. americanus*, on the road, on the curbs and adjacent paving. The toads were along the road for several hundred yards north and south of the Pierces Cove area of the Loch Raven Water Shed. In Maryland, American toads are Explosive Breeders, which emerge in large numbers and breed over a short period (Lee, 1973). I have observed the toads breeding in previous years, in the ponds and adjacent flood plain of Pierce's Cove Stream or Morgan Mill Run.

Many of the toads were in amphexus, and egg laying was proceeding. This night, however, I did not hear any of the shrill whistling calls typical of the males during the breeding season. Why the toads were "breeding" on the road surface instead of in the ponds is a mystery. It was raining, very warm and breezy, with a full moon.

Olfactory cues were once believed responsible for amphibians orientation to the breeding ponds. Recent studies, however, on migrating amphibians such as spotted salamanders, *Ambystoma maculatum,* indicate that even after the animals' nasal epithelium has been cauterized, they still were able to find the breeding ponds.

The asphalt road surface on this night was wet and appeared shiny in the moonlight. If the toads use visual cues to locate breeding sites, perhaps this confused them into thinking the roadway was the breeding pond. We stopped the car along the way trying to remove to safety as many toads as possible. Our efforts were almost useless, as the toads returned to the road. The toads were gone the next night, even the dead ones. It is interesting to note that due to the large number of dead toads, it is hard to account for predators alone consuming the carcases, as some must have been cleaned up by the County Roads Department or the Watershed Police due to the slippery road conditions created.

I would like to thank Dr. Donald Forrester, Professor of Herpetology, Towson State University, and Herbert S. Harris, Jr., Curator of Herpetology, Natural History Society of Maryland, Inc., for their help and encouragement in the preparation of this note.

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— John Donald Cochran, Maryland Herpetological Society, Natural History Society of Maryland, Inc., 2643 N. Charles St., Baltimore, MD 21218.

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NEW HERPETOLOGICAL STATE RECORDS FOR MEXICO

The collections of the Instituto de Biología de la Universidad Nacional Autónoma de México contain specimens of several species of amphibians and reptiles from Mexican states from which they have not hitherto been reported. The following records are from seven states, for which 22 taxa are newly reported, as follows: CHIAPAS-*Agalychnis callidryas;* HIDALGO-*Corytophanes hernandezi, Elaphe f. flavirufa;* JALISCO-*Phrynohyas venulosa, Tomodactylus nitidus orarius, Triprion spatulatus reticulatus, Coleonyx elegans nemoralis, Eumeces parvulus, Mabuya brachypoda, Phrynosoma asio, Dipsas gaigeae, Loxocemus bicolor, Micrurus distans oliveri, Pseudoleptodeira latifasciata, Tropidodipsas, occidentalis, T. philippi;* PUEBLA-*Coniophanes bipunctatus biseriatus, Spilotes pullatus mexicanus, Tropidodipsas s. sartorii;* SAN LUIS POTOSI-*Chiropterotriton chondrostega cracens;* VERACRUZ-*Siren intermedia;* ZACATECAS-*Rana montezumai.*

Information concerning the specimens reported herein, or any others in the herpetological collections of the Instituto de Biología (IBH), may be obtained from the third author, curator of these collections. We are much indebted to Dr. Hobart M. Smith, Biol. Oscar Sánchez, Guillermo Lara and Edmundo Pérez Ramos for their aid and advice.

CAUDATA

Chiropterotriton chondrostega cracens. San Luis Potosi: Sotano de Las Golondrinas, G. Fernández, 9 April 1974 (IBH 2432, two specimens). Previously recorded only from Tamaulipas.

Siren intermedia. Veracruz: Rancho La Magdalena, 2 km E Gutiérrez Zamora, J. Riaño Montini, 15 August 1977 (IBH 1760, four specimens). Previously reported only from northern Tamaulipas.

ANURA

Agalychnis callidryas. Chiapas: Laguna Bélgica, M. Lemus and S. López de Lara, 7 September 1979 (IBH 2483, two specimens). Previously recorded from states to the north, and in Central America, on Atlantic slopes.

Phrynohyas venulosa. Jalisco: 1 km E Cuitzmalá, mpio. La Huerta, G. Casas and G. Lara, 24 October 1976 (IBH 2611, two specimens). Previously reported from numerous states on both coasts.

Rana montezumai. Zacatecas: Santa Cruz, 10 mi W Fresnillo, B. Shaffer, 12 August 1980 (IBH 2764, several tadpoles and adults). Previously recorded from numerous states on the central plateau.

Tomodactylus nitidus orarius. Jalisco: Chamela, Estación de Biología, A. Ramírez, 22 October 1979 (IBH 2662); 6 km SE Chamela, mpio. La Huerta, 22 November 1977, G. Casas and A. Ramírez (IBH 2663). Previously recorded from the adjacent states of Colima, Michoacan and Nayarit.

Triprion spatulatus reticulatus. Jalisco: Chamela, Estación de Biología, 21 June 1977, G. Casas, and 5 September 1980, G. Casas and G. Ruíz (IBH 2635-6). Previously recorded from Colima, Guerrero, Michoacán and Oaxaca.

LACERTILIA

Coleonyx elegans nemoralis. Jalisco: 5 km SE Chamela, mpio. La Huerta, 4 June 1973, M. A. Gurrola (IBH 2142, two specimens). Previously reported from Colima, Michoacán, Morelos, and Oaxaca.

Corytophanes hernandezi. Hidalgo: Calnalí, date and collector unknown (IBH 1746). Previously recorded from Atlantic slopes in San Luis Potosi, Veracruz and more southerly states.

Eumeces parvulus. Jalisco: 6 km E Chamela, Estación de Biología, 22 November 1977, G. Casas and A. Ramírez (IBH 2143, two specimens). Previously recorded from Colima, Michoacán, Nayarit and Sinaloa.

Mabuya brachypoda. Jalisco: Isla Cocina, 4 km NW Chamela, 25 March 1972, C. Sánchez H. (IBH 2165); Agua Caliente, km 30, Melaque-Puerto Vallarta, mpio. La Huerta, October, 1976, G. Lara and G. Casas (IBH 2167). The northernmost localities recorded previously are in Michoacán.

Phrynosoma asio. Jalisco: Chamela, Estación de Biología, 24 September, 1980, A. Pérez (IBH 2774). Previously reported only as far north as Colima.

SERPENTES

Coniophanes bipunctatus biseriatus. Puebla: Rancho Las Margaritas, Hueytamalco, August 1975, W. López-Forment (IBH 2304). Previously recorded from adjacent areas to the east, and southward (Campeche, Chiapas, Oaxaca, Tabasco, Veracruz).

Dipsas gaigeae. Jalisco: Chamela, Estación de Biología, September 1974, June 1975, 17 September 1975, M. Garcia (IBH 2037-9). Previously recorded only from the state of Colima.

Elaphe f. flavirufa: Hidalgo: Huejutla, September 1954, J. Valdez (IBH 758). Previously reported from more eastward states, Tamaulipas to Yucatán and Chiapas, including Querétaro.

Loxocemus bicolor. Jalisco: 1 km S Agua Caliente, on road to Chamela, 4 February 1972, C. Sanchez H. (IBH 2006); Chamela, Estación de Biología, July 1978, M. Gurrola (IBH 2054). Previously recorded from Pacific slopes, Colima to Chiapas.

Micrurus distans oliveri. Jalisco: Chamela, 6 km E Chamela and 8 km E Chamela, Estación de Biología, 26 July 1970, 24 May 1974 and 25 February 1975, G. Casas, M. García and A. Pérez (IBH 2062-5). Previously recorded only from the state of Colima.

Pseudoleptodeira latifasciata. Jalisco: Chamela, 27 September 1980, A. Ramírez (IBH 2772); Playa Careyes, 10 km SE Chamela, 19 June 1979, G. Casas (IBH 2630).

Spilotes pullatus mexicanus. Puebla: Rancho Las Margaritas, Hueytamalco, August 1975, W. López Forment (IBH 1761). Previously recorded from numerous Atlantic slope states, Tamaulipas to Chiapas and Quintana Roo.

Tropidodipsas occidentalis. Jalisco: 6 km E Chamela, Estación de Biología, 16 Sept. 1975, G. Casas (IBH 2043). Previously recorded from Colima, Michoacán, Nayarit and Sinaloa.

Tropidodipsas philippi. Jalisco: Río Cuitzmala, 3 km S Emiliano Zapata, mpio. La Huerta, 23 October 1976, G. Casas and G. Lara (IBH 2056). Previously recorded from Colima, Nayarit and Sinaloa.

Tropidodipsas s. sartorii. Puebla: Rancho La Cardina, NE Hueytamalco, November 1980, B. Villa Ramírez (IBH 2815); Venustiano Carranza, Rancho Ojo de Agua, 30 km SW Poza Rica, 5 March 1977, L. D. Possani (IBH 1697). Previously reported from Atlantic slope states from San Luis Potosi to Chiapas and Quintana Roo.

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CLIMBING ABILITY OF BOX TURTLES

While doing research on box turtles during the summer of 1981, I witnessed two indigenous species, *Terrapene ornata ornata* and *T. carolina triunguis*, climb a 77 cm high vertical fence constructed of 1.3 cm^2 wire mesh and finished off on top by a 13 cm flat railing.

When working with the turtles, a few were removed at a time from holding pens in the yard and placed on the deck adjoining the author's house. The turtles would first investigate their new surroundings, then several would congregate in the corners. On many occasions turtles attempted to climb but eventually fell. Most attempts were made near corners; one in fact did climb the corner with left feet on one section of the fence and right feet on the section which joined at a right angle. When the top was gained, the turtles would peer over the edge, move down the railing a short distance, look again, and continue in this manner. Since it is a 2 m drop on the outside of the fence, the author chose not to let a turtle fall. However, one turtle did disappear presumably by climbing the fence, falling, and escaping. Another was later recovered in the yard having accomplished the same feat.

Since climbing turtles were a nuisance to the author who was more concerned with preventing their escape than with their gymnastic abilities, precise notes were not always made. *T. o. ornata* was more often seen climbing and more often successful than *T. c. triunguis*. The ability to climb successfully was limited to medium-sized turtles; juveniles were never seen attempting to climb, and older and larger turtles were unsuccessful presumably due to their cumbersomeness and weight. One female *T. o. ornata* became so proficient that she made the climb repeatedly. When she would attain the top, I would place her back on the deck and she would immediately climb again (Figure 1).

The morphological characteristic of *T. o. ornata's* lower domed shell giving it a lower center of gravity enables it to climb steep grades more efficiently than *T. c. triunguis*. Also possibly related to *T. o. ornata's* superior abilities may be its occupancy of more varied habitats (Legler, 1960), which would suggest more versatile behavior than a species living in a less varied environment. Perhaps also involved is *T. o. ornata's* more aggressive nature. Although 53% of the total turtle population was *T. o. ornata*, they comprised 82% of the escapees.

ACKNOWLEDGMENTS

I want to thank Dr. Donald A. Ingold for his helpful comments on the manuscript.

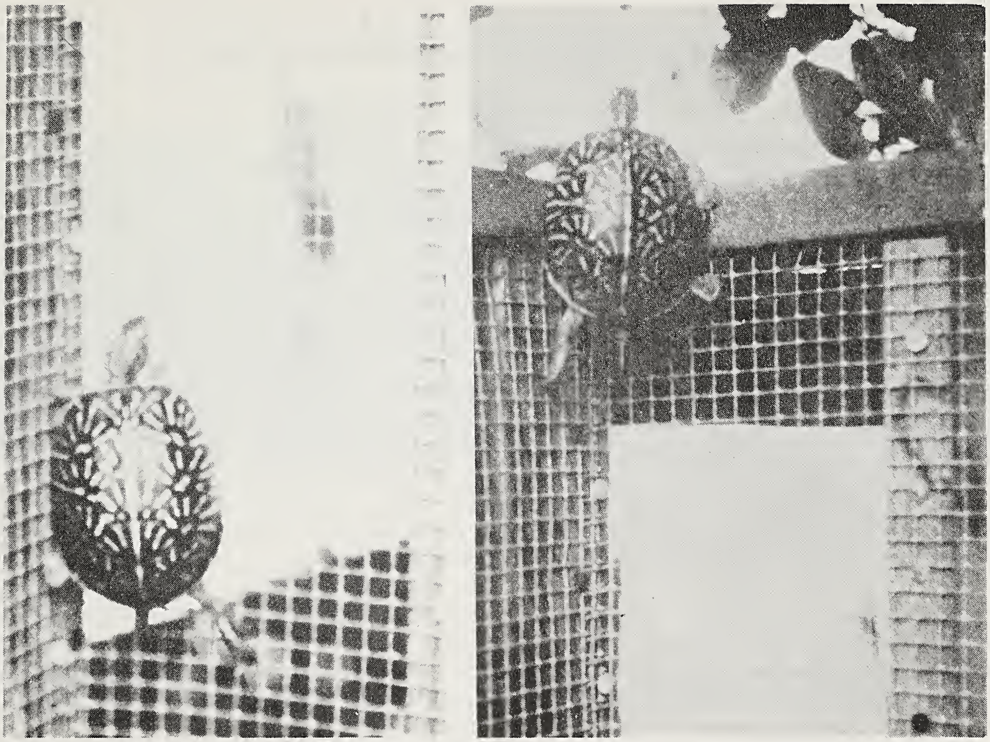

Figure 1. Photographs of *T. o. ornata* illustrating its ability to climb.

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Accepted 29 July 1982

A RANGE EXTENSION FOR THE ALLIGATOR LIZARD

Barisia gadovi levigata

The status and range of *Barisia gadovi levigata* Tihen (1949) has never been clarified. The only description is the original, based on two specimens from 9000 ft in mountains on the west side of the Valley of Oaxaca (= Sierra de Cuatro Venados). Indeed, only one other locality has been reported, by Bogert and Porter (1967) - Tejocotes, Oaxaca, 2500 m.

The range (as well as variation) of *B. g. gadovi* is somewhat better known, as reported by Gadow (1905), Hall (1951), Stebbins (1958) and Davis and Dixon (1961), but all localities are in the Sierra Madre del Sur somewhat west and south of the Valley of Chilpancingo, Guerrero. Hence a continuity of range between the two taxa is as yet conjectural although probably existent because of continuity of habitat throughout the Sierra Madre del Sur of Oaxaca and Guerrero.

Thus, a specimen (Univ. Colo. Mus. 54215, field no. 51730) obtained by the first author (JCS) on Cerro Yucuyagua, 2675 m, on July 3, 1981, is of interest as an indicator of validity and range of *levigata* since the locality, 8 km SSE Tlaxiaco, is about 110 airline km W of Oaxaca and only about 40 km E of the Guerrero-Oaxaca border.

The specimen (Figure 1) is an adult male, 100 mm S-V, with 47 dorsals inclusive from postoccipital to level of rear margin of thighs, in 18 longitudinal rows; 56 ventrals inclusive from postmentals to anus, in 12 longitudinal rows; minimum longitudinal nuchal rows 8; no sharp keels on any dorsal scales, even on the 23 mm of unregenerated tail (56 mm regenerated), as seen under magnification (to the naked eye keels appear to be present on the median 6-8 rows, as seen in certain light, but actually the scales are smoothly and weakly convex, more accentuated in the sacral region); venter black-spotted, dorsum dark brownish gray in preservative; cephalic scutellation typical, with 5 inner, 3 outer supraoculars; a large frontonasal; postrostral present; 2 loreals, posterior widely separated from upper postnasal; 2 postnasals; supranasal present, narrow, 3 pairs of chinshields (wider than long), scales of only anterior pair in contact; 4-4 primary and secondary temporals.

In life a series of narrow, chevron-shaped black crossbars, one scale wide and apices caudad, extend from neck onto tail, separated from each other by dark brown interspaces of the same width. The black crossbars are conspicuous on sides of body, irregularly vertical, numbering 15 between axilla and groin; each lateral black bar is bordered by several (3-4), small, bright yellow, round dots; the interspaces are bright brick red, fading ventrally to a bluish gray, the same color as the light interspaces on the venter between the scattered, profuse black checks.

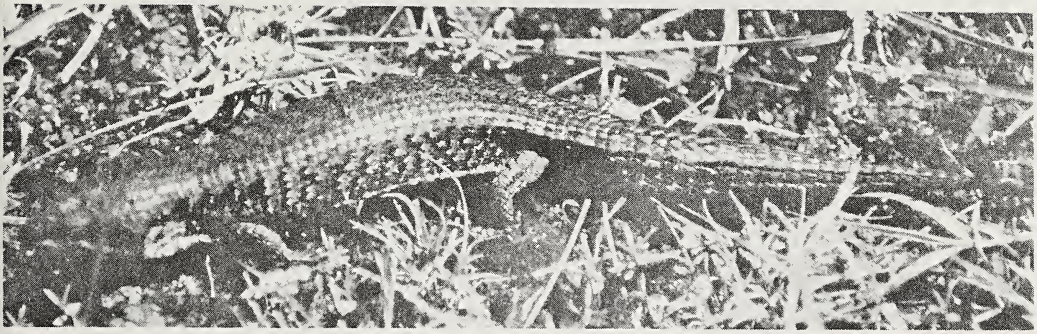

Figure 1. *Barisia gadovi levigata*, adult male, 100 mm S-V, from Cerro Yucuyagua, Oaxaca (see text). Photographed in life, reproduced from a color transparency.

Our study of the literature and of this specimen as well as of four examples (UCM 50632-5) of *B. g. gadovi* from the vicinity of Asoleadero, Guerrero, leads us to believe that only one feature distinguishes the two subspecies: presence of sharp keels on the 8-10 medial dorsal scale rows, and weak keels on the other rows, in the nominate subspecies, and their absence in *levigata*. Both adults (81.5, 91 mm S-V) and young (38, 42 mm S-V) stages of the nominate race exhibit strong, sharp keels. On the basis of that character the Yucuyagua specimen clearly represents *levigata*, and reveals no tendency toward intergradation with *g. gadovi*. Presumably intergradation, if it occurs at all, does so farther west, probably in eastern Guerrero.

Other characters suggested by Tihen as differentiating the two subspecies do not appear to do so. The posterior loreal, supposedly contacting the upper postnasal in *levigata*, separated in *g. gadovi*, is separated in our *levigata*, in contact on one side of one *g. gadovi* (narrowly separated on the other). The supposedly more brownish pigmentation of the Oaxaca subspecies, as opposed to the more blackish pigmentation of the Guerrero form, likewise does not distinguish our specimen, which in color is inseparable from the Guerrero material in preservative. There may be an average difference in longitudinal dorsal scale

count, as the three counts available for *levigata* range from 45-47, whereas the counts given by Tihen (*op. cit.*) for Guerrero specimens range from 46-51, mean 48.4. The ventral counts, 51-52 for *levigata* and 52-56, mean 54, for *g. gadovi* as recorded by Tihen, seem unlikely to be useful diagnostically since our specimen has 56.

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—John C. Spengler and Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colo., U.S.A., 80309; and* Gustavo Casas-Andreu, *Instituto de Biología, UNAM, Apartado Postal 70-153, México, D.F. 04510.*

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Accepted 17 August 1982

NEWS AND NOTES:

EASTERN SEABOARD HERPETOLOGICAL LEAGUE MEETING

Date:	October 16, 1982
Sponsored by:	Connecticut Herpetological Society
Hosted by:	Peabody Museum of Natural History, New Haven, CT

PROGRAM

10:00 a.m.	Registration and Refreshments
10:30 a.m.	Welcome by Dr. Mike Uricheck and Tony Douglas
10:45 a.m.	The Reptile's Eye by Alden Mead, Ophthalmology and Visual Science, Yale University.
11:15 a.m.	Breeding Captive Kingsnakes (Lampropeltis) by Steven Fuller, Director, Hidden Valley Nature Center.
12:00 Noon	Lunch
1:15 p.m.	Medicine and Care of Captive Reptiles by Dr. George Whitney, Whitney Veterinary Clinic, Orange, CT.
2:00 p.m.	The Warm Blooded Dinosaur by Dr. John Ostrom, Curator, Paleontology, Peabody Museum, Editor, American Journal of Science.
3:00 p.m.	Hour break to visit Museum. Note: ESHL Representatives to meet in Auditorium.
4:00 p.m.	Reptiles and Amphibians of Connecticut by Richard Peterson, founding member CHS.
4:30 p.m.	Reptiles and Amphibians of Massachusetts by Tom Tyning, MAHS.
5:00 p.m.	Reptiles of Rhode Island by Chris Rethail.
5:30 p.m.	Reptiles and Amphibians of New Hampshire by Mark De Muhles.
6:00 p.m.	The Red-Belly Turtle in Rhode Island.
6:30 p.m.	Closing Address by Dr. Mike Uricheck

Directions to Peabody Museum, New Haven, CT

From South on Route 95: Continue on 95 through New York and Connecticut until you reach New Haven. In New Haven, take Interstate 91 North towards Hartford and Springfield. Shortly after entering on 91 you will take Exit 3 - Trumbull Street. At bottom of exit is your first stoplight; go straight through. At second stoplight you will be at Whitney Avenue; take a right on Whitney. At the next stoplight you will see the Peabody Museum on your left. Park in designated area.

From Rhode Island and East on 95: Continue on I-95 through Guilford and Branford. Upon reaching New Haven take the same direction as above for I-91 towards Hartford and Springfield.

From North and Hartford: Take Interstate 91 South to New Haven. Take Exit 3 - Trumbull Street, and follow above directions from there. For those taking trains into New Haven RR Station, there are regularly scheduled buses out of the station going past the Peabody Museum. The same is true for flights into Tweed New Haven Airport.

NEWS AND NOTES:

SSAR GRANTS-IN-HERPETOLOGY

The Society for the Study of Amphibians and Reptiles is pleased to announce that proposals are now being accepted for the 1982 Grants-In-Herpetology Program. This program is designed to provide financial support to deserving individuals or organizations engaged in research on or conservation of amphibians and reptiles. Grant proposals will be considered in the following areas:

1. HERPETOLOGY-ORIENTED CONSERVATION. Proposals should address research on endangered or threatened species at the state, national or international levels, or address research on critical herpetological habitats. Proposals may be received from individuals only.

2. GRADUATE STUDENT HERPETOLOGICAL RESEARCH. Proposals may address any herpetological research endeavor and may be submitted by individual graduate students only, with a letter of support from the student's major advisor or committee chairperson.

3. REGIONAL HERPETOLOGICAL SOCIETY PROGRAMS OR PROJECTS. Proposals may address any herpetological research endeavor or project, provided said endeavor or project concerns herpetology within the implied geographic limits of the regional society. Proposals may be submitted by regional herpetological societies or by individuals. If the latter, a sponsoring letter from the current societal president or an advisor should accompany the proposal.

4. HERPETOLOGICAL RESEARCH IN ZOOS. Proposals may address any herpetological research endeavor which is conducted at a zoo. A letter from the represented zoo or supporting institution should accompany the proposal.

Each proposal should include the following information: A) Background & Objectives of the proposed project, in terms of its relevance to herpetology, B) Methods of carrying out the research or conducting the project, C) Budget for the project, according to the guidelines set forth below, and D) Letter of Support (if applicable). Proposals should be relatively brief (approximately 5 typed pages).

Budgets for the proposals should not exceed $250 in each category. The budget request should specifically relate to the project under consideration.

Successful applicants will be expected to submit to SSAR a

written report of the results of their research or project, within a reasonable time after the project year is completed. They are also encouraged to submit for publication the results of their research or project, preferably to The Journal of Herpetology or Herpetological Review.

Members of the SSAR Grants-In-Herpetology Committee will evaluate all proposals, projects or programs. Committee members are: Martin J. Rosenberg (Chairperson), Terry Graham, Ralph Axtell, Lyndon Mitchell, and John Iverson.

Inidividuals submitting proposals should designate to which of the four areas their proposal applies. All proposals must be typewritten and submitted in duplicate to:

Martin J. Rosenberg
Department of Biology
Case Western Reserve University
Cleveland, Ohio 44106

NEWS AND NOTES:

SNAKE SPECIALIAST GROUP OF THE INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE SPECIES SURVIVAL COMMISSION

The first meeting of the Snake Specialist Group of the IUCN/SSC will be held at the Madras Crocodile Bank, India, from 8th to 12th November 1982. We expect participants from several countries to attend. The meeting is open to all herpetologists. Anyone wishing to attend should inform us at the earliest, mentioning which hotel accommodation is desired. Trips to see South Indian herps will be arranged as mentioned below:

Accommodation	per day
Golden Beach	US $7 single, US $10 double
Fisherman's Cover	US $20 single
Silversands	US $11 single, US $14 double
Temple Bay*	US $14 single, US $20 double

* We recommend this one.

Food: About US $5 per day

Field Trips: 1) Local herp places $10 (one day trip with food)
2) Western Ghats $100 (5 day trip with food)

Contact: Mr. Romulus Whitaker, Director, Madras Snake Park Trust, Raj Bhavan P.O., Madras 600 022, INDIA

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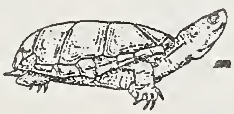

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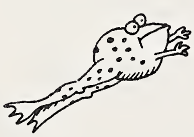

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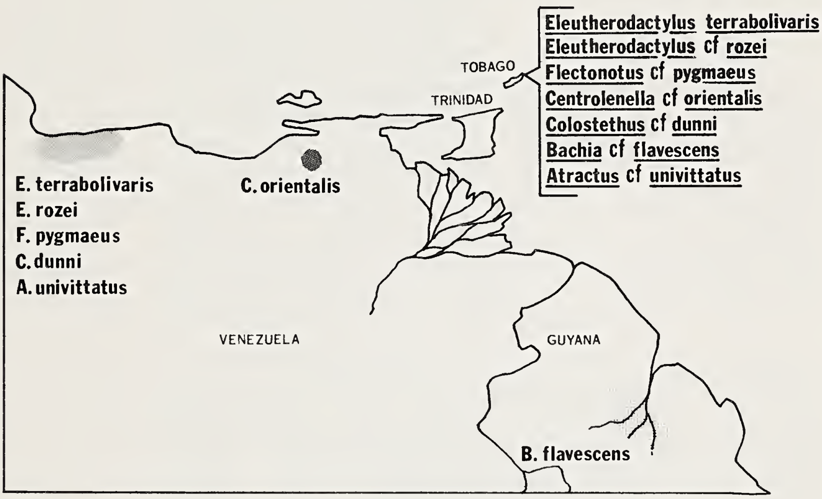
Page 98, Fig. 29 ... The name *C. dunni* should replace *C. orientalis* in the left hand column of names. The corrected map is printed below. It can be either cut out or xeroxed and pasted over the incorrect map in the last issue.



Other typographical errors in order of occurrence:
Page 39, Fig. 3, legend, line 2: sources, not resources.
Page 49, Paragraph 2, line 2: pselaphid, not pselaphis.
Page 63, 9): *Flectonotus* cf *pygmaeus,* not *F.* cf *pygmaea.*
Page 87, Figure 22, legend: *Erythrolamprus,* not *Erythrolampsur.*
Page 96, Table I, snakes, 3rd name: *Corallus,* not *Cozallus.*
Page 111, line 6: *Oxybelis fulgidus,* not *O. fulgidos.*
Page 111, line 11: *Spilotes pullatus pullatus,* not *S. p. pullatui.*
Page 121, 5th name: Dauxion-Lavaysse, not Lavaysie.

— Jerry David Hardy, Jr., *Dept. Herpetology, Natural History Society of Maryland, Inc., 2643 N. Charles St., Baltimore, Maryland 21218.*

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DECEMBER 1982

VOLUME 18 NUMBER 4

Bulletin of the Maryland Herpetological Society

Volume 18 Number 4 December 1982

CONTENTS

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Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
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BULLETIN OF THE

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Volume 18 Number 4 December 1982

The Maryland Herpetological Society

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BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

VOLUME 18 | 30 DECEMBER 1982 | NUMBER 4

THE TAXONOMIC RELATIONSHIPS OF THE MEXICAN LIZARD SPECIES *SCELOPORUS HORRIDUS*

By Thomas H. Boyer, Hobart M. Smith
and Gustavo Casas Andreu

Although Boulenger (1897), in his revision of the lizards of the genus *Sceloporus*, regarded *Sceloporus horridus* Wiegmann (1834) a subspecies of *S. spinosus* Wiegmann (1828), Smith (1939) interpreted them as allospecific, because at that time evidence indicated that their ranges approached most closely in the upper basin of the Río Balsas in Oaxaca, where specimens of both species revealed no evidence of intergradation. There the matter has rested ever since, with no contrary evidence made known.

However, nine specimens secured in June of 1981 in the vicinity of Tlaxiaco, Oaxaca, by the senior author, Karen Prescott and John Spengler, clearly are intermediate in diagnostic characteristics between the two taxa, and require return to Boulenger's arrangement of them. The specimens are ultimately to be divided equally between the University of Colorado Museum, the Instituto de Biología of the Universidad Nacional Autónoma de México and the Dirección General de la Fauna Silvestre in Mexico City.

Salient character states of the nine specimens from near Tlaxiaco are as follows: s-v, 61-102 mm; dorsals 27-29, $\bar{X}$ 28.1; supraoculars 4-5, $\bar{X}$ 4.4; femoral pores 8-11, $\bar{X}$ 9.5; prefrontals separated by an azygous scale in three, by contact by median frontonasal and frontal in six; 0-0 supraoculars contacting median head scales in three, 1-1 in two, 1-2 in three, 2-2 in one ($\bar{X}$ 1.1).

Three subspecies of *S. spinosus* are currently recognized in Oaxaca (*spinosus*, *caeruleopunctatus*, *apicalis*), and one of *S. horridus* (*horridus*). In these four, respectively, the dorsals are 26-32 ($\bar{X}$ 28.7, N 67), 28-37 ($\bar{X}$ 32.6, N 75), 27-33 ($\bar{X}$ 28.5, N 36), and 28-34 ($\bar{X}$ 30.5, N 37); supraoculars 4-6 ($\bar{X}$ 4.4, N 168), 4-6 ($\bar{X}$ 5.1, N 145), 4-6 ($\bar{X}$ 4.9, N 70), 3-5 ($\bar{X}$ 4, N 136); femoral pores 6-12 ($\bar{X}$ 8.6, N 236), 8-14 ($\bar{X}$ 11, N 151), 7-11 ($\bar{X}$ 8.2, N 72), 2-6 ($\bar{X}$ 4, N 320); prefrontals contacting in 11.5% (6 in 52), 28% (5 in 18), 88% (22 in 25), 31% (26 in 85); one or more supraoculars contacting median head scales on one side in 8% (14 in 168), 3% (1 in 36 sides), much the same, 98% (315 in 320).

S. s. apicalis, far to the south, is presumably not involved with the population represented by the Tlaxiaco series; it furthermore

differs markedly from the latter by usually having the prefrontals contacting medially (88% vs 0%) and having usually five or six supraoculars (97% vs 39%).

S. s. caeruleopunctatus occupies an similarly disjunct range in central Oaxaca, and is markedly different from the Tlaxiaco series in having more numerous dorsals, usually 30 or more (93% vs 0%).

S. s. spinosus has a range more closely approaching that of *S. h. horridus* than any other of its complex, occurring as far south as Tehuacán, Puebla, only some 20 km NNE of Zapotitlán Salinas, whence *S. h. horridus* is known (Smith, 1939: 106). Other localities for the latter taxon in extreme northern Oaxaca include Cuicatlán, in the same drainage system (Río Papaloapam) as Zapotitlán Salinas and Tehuacán, and Chazumba and Huajuapan de León, both in the Río Balsas drainage system, where Tlaxiaco also lies although considerably farther south.

S. h. horridus differs from *S. s. spinosus* most conspicuously in number of femoral pores, always having six or fewer (100% vs 0.8%), and rarely having all supraoculars separated from the median head scales (3% vs 92%).

The Tlaxiaco series thus is fully conformant with *S. s. spinosus* in femoral pore count, with 8-11. However, since only three of the nine have the supraoculars completely separated from the median head scales, three having two supraoculars contacting the median head scales on one side (one on the other) and one having two on both sides (only one *S. s. spinosus* in 168 had two, and only on one side), the Tlaxiaco series is more like *S. h. horridus* in this character.

In number of supraoculars, however, the Tlaxiaco series conforms with neither *S. s. spinosus* nor *S. h. horridus*, since 39% of the 18 Tlaxiaco counts are five (61% four), whereas only 19% with 5 or more occurs in 168 *S. s. spinosus* and 2% in 136 *S. h. horridus*. The only possible influence for more numerous supraoculars is *S. s. caeruleopunctatus*, which has five or more supraoculars in 97% of 145 counts. The high number of femoral pores in the Tlaxiaco series (39% with 10 or more - 7 of 18 counts) does in fact suggest the influence of *S. s. caeruleopunctatus* (with 87% 10 or more, 132 in 151 counts) rather than *S. s. spinosus* (with only 19% 10 or more, 46 in 236 counts). Yet the Tlaxiaco series has fewer dorsals (vide supra) and 67% have the supraoculars contacting median head scales (rarely - 3% - in *S. s. caeruleopunctatus*).

The conclusion seems unavoidable that the Tlaxiaco series represents intergrades between the complexes formerly regarded as constituting the species *S. spinosus* and *S. horridus*, and that the taxa involved are *S. h. horridus* and *S. s. caeruleopunctatus*, between the known ranges of which Tlaxiaco lies, somewhat nearer the former than the latter. The details of interrelationships of the populations of nominate *spinosus, horridus,* and *caeruleopunctatus* remain to be determined

by intensive field work where the ranges contact or are most closely approximated.

Since all taxa of both the *spinosus* and *horridus* complexes are allopatric and, presumably, serially parapatric, all are properly interpreted as members of one species, as follows: *S. s. spinosus* Wiegmann, 1828; *S. s. albiventris* Smith, 1939; *S. s. apicalis* Smith and Smith, 1951; *S. s. caeruleopunctatus* Smith, 1938; *S. s. horridus* Wiegmann, 1834; and *S. s. oligoporus* Cope, 1864.

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Department of Environmental, Population and Organismic Biology, University of Colorado 334, Boulder, Colorado 80309 (THB and HMS); and Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónomá de México, Apartado Postal 70-399, México 04510, Distrito Federal, México (GCA).

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Accepted 23 November 1982

THE GENDER OF THE NOMINAL SNAKE GENUS SIBON

The gender of *Sibon* Fitzinger, 1826, has been regarded as neuter by some workers (*e.g.*, Cope, 1887: 67), masculine by some (*e.g.* Smith and Taylor, 1945: 126) and feminine by others (*e.g.* Peters, 1960: 168-9), although in no work has gender been discussed. Since Peters recognized 13 taxa in the genus, and at least one (*S. nebulatus*) is widely distributed and frequently cited, agreement upon generic gender and thus the endings for adjectival species-group names, which must agree in gender with the generic name to which they are assigned, is of some importance.

Sibon is not a classical word, although it closely approaches both Greek and Latin words relating to "spear", and presumably was derived from them in reference to the lancelike shape of head and neck. The International Code of Zoological Nomenclature clearly states (Art. 30b) that genus-group names of non-classical origin are to take the gender implied by originally-associated species-group names. Even if the name is regarded as of classical origin and if its gender is variable in Latin or Greek, in nomenclature (Art. 30a2) its gender is to be accepted as masculine unless the original author implies otherwise by the originally-associated species-group names.

Fitzinger (1826: 29, 30, 60) included three nominal species in the genus: *annulatus, nebulatus* and *catenularis*, thereby clearly implying his acceptance of masculine gender for the generic name. Therefore if *Sibon* is regarded as non-classical in origin, its gender was fixed by Fitzinger as masculine.

If *Sibon* were to be regarded as classical in origin, it could have been derived from either neuter, masculine or feminine words. No one is more probable than the others and none was indicated in the original description. Therefore, by both implication of the original author and by blanket policy, as stated in Art. 30a2 of the Code, masculine is the proper gender assignable to *Sibon.*

We accordingly conclude that the current code requires *Sibon* Fitzinger 1826 be treated as a masculine word with which adjectival species-group names must agree, with their endings modified to so indicate, *e.g. S. annulatus, S. dimidiatus, S. nebulatus* and *S. sanniolus*.

It may be noted in passing that a synonym of *Sibon, Petalognathus*, is commonly (*e.g.* Peters, *loc. cit.*) attributed to Duméril (1853: 466). Actually Duméril's usage there was only in the French vernacular ("Les Petalognathes"), which is unacceptable in nomenclature (Art. 11b of the Code). The first acceptable Latinized use appeared a year later in the work by Duméril, Bibron and Duméril (1854, 7: 463).

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—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado 334, Boulder, 80309.*

Received 24 August 1982
Accepted 15 September 1982

COMPARISONS OF PATTERN AND COLOR IN LIFE OF THE SUBSPECIES OF THE TURTLE *PSEUDEMYS SCRIPTA* IN CHIAPAS, MEXICO

The brief summary given by Legler (Moll and Legler, 1971:4) of the geographic races of *Pseudemys scripta* recognizes two subspecies in the state of Chiapas, Mexico: *P.s. venusta* (Gray) of Atlantic slopes, *P.s. grayi* (Bocourt) of the Pacific. (*Emys umbra* Bocourt, 1878, was mistakenly substituted for *E. grayi* Bocourt, 1868, under the impression that it was preoccupied by *E. grayi* Gunther, which actually did not appear until 1869.) These two subspecies are dichopatric, but their isolating mechanisms are much more than simply geographic. The senior author has kept examples of each together over a period of 20 years or more, in a pool where ample opportunity for interbreeding exists, yet they have never taken it, although each breeds regularly with its own kind. Were it not for populational interchange in Central America of the vicarious subspecies occurring there, these two taxonomic representatives of this widely distributed formenkreis would be regarded as belonging to different species.

Observations over many years of individuals of each subspecies, as now understood, have revealed numerous differences in color, whereby unknowns can readily be identified as *P.s. venusta* or *P.s. grayi*. The accompanying table summarizes those differences.

It may be noted that whereas the Pacific slope *P.s. grayi* is of uniform appearance throughout its range in Chiapas, the Atlantic slope populations exhibit considerable geographic variation, suggesting that they may in reality represent two or three subspecies. Although the central plateau of Chiapas is drained on the Atlantic side by two major river systems (Grijalva and Usumacinta), *P. scripta* occurs on the plateau only in the former, where it is known in Rio Lagartero and Lagunas de Cristal (both in quadrant 16-092-4).

Table 1. Color Comparisons in Life of the *P. scripta* Subspecies of Chiapas

	venusta	*grayi*
	Juvenile, 8-day	
Carapace above	Laminae with ocelli surrounded by wide orange circle	Ocelli surrounded with narrow, pale yellow circle
Marginal scutes below	Orange-yellow, with small ocelli	Large ocelli, narrow pale yellow margin

Plastron	Orange-yellow	Pale straw yellow
Skin markings	Wide, orange-yellow stripes	Narrow, pale, straw-yellow
Temporal stripe	Wide, orange near eye	Narrow, all pale yellow
Limbs-tail stripes	Bright yellow, with narrow olivaceous edging	Pale yellow, divided by grayish olive stripes
Hind leg edging	Yellow	Olive
Skin tone	Yellow dominant	Grayish olive dominant, or equal to yellow
	Adult	
Carapace	Olive green, ocelli encircled by orange	Dusky brown, often small black spot near center of each lamina
Skin markings	Wide orange-yellow stripes, no. and width varying geographically	Narrow, pale yellowish stripes, or none
Ground color of skin	Greenish olive	Dusky brown
Hind leg edging	Yellow	None
Skin general tone	Yellow dominant	Dusky brown

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1971. The life history of a neotropical slider turtle, *Pseudemys scripta* (Schoepff), in Panama. *Bull. Los Angeles County Mus., Nat. Hist.*, (11):1-102, figs 1-56.

—Miguel Alvarez del Toro and Hobart M. Smith, *Instituto de Historia Natural, Departamento de Zoología, Aptdo. Postal 6, Tuxtla Gutiérrez, Chiapas, México, and Dept. of E.P.O. Biology, Univ. of Colorado 334, Boulder, Colorado 80309.*

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Accepted 17 September 1982

PREDATORY BEHAVIOR IN A CONGENITALLY ALINGUAL RUSSELL'S VIPER (*VIPERA RUSSELLI*). 1. STRIKE-INDUCED CHEMOSENSORY SEARCHING

James Carr, Roy Maxion, Matthew Sharps, David Weiss,
Barbara O'Connell, and David Chiszar

Abstract

A congenitally tonguless Russell's viper (*Vipera russelli*; San Diego Zoo inventory #381139, now 18 mo old) exhibited a sustained, high rate of locomotion after striking mice but not after seeing and/or smelling mice. The snake recognized mouse carcasses as food, and chemical cues appeared to be involved because the snake poked at the carcasses with slightly parted jaws as if an attempt was being made to sample molecules It is concluded that this specimen has functional vomeronasal organs and that some chemical cues reach these organs without lingual transport. The searching behavior induced by striking rodent prey was topographically similar to the strike-induced chemosensory searching seen in many viperids.

The vomeronasal system (tongue plus Jacobson's organs) is centrally involved in ophidian predatory behavior as well as reproductive and social behavior (see Burghardt, 1970, for a review). Surgical obstruction of Jacobson's organs results in drastic deficits in several aspects of feeding behavior in garter snakes (Halpern & Frumin, 1979; Kubie, 1977; Kubie & Halpern, 1979), and amputation of the tongue also has decremental effects (Wilde, 1938). However, "Burghardt and Pruitt (1975) showed that virtually complete removal of the tongue was necessary to abolish feeding in newborn garter snakes. Recovery was possible if any stub would protrude from the jaws and a completely tongueless adult continued to find and eat earthworms, albeit abnormally, for five years until her apparently natural death" (Burghardt, 1980, page 277). Hence, it is clear that Jacobson's organs are critical for ophidian feeding and that tongue flicking is the major, though perhaps not the exclusive, means of bringing chemical cues to Jacobson's organs (see also Gillingham & Clark, 1980; Kahmann, 1932; Kubie, 1977; Meredith & Burghardt, 1978; Distel, 1978).

Congenitally tongueless snakes are rare. A litter of boas (*Boa constrictor*) born at N.Y. Zoological Park contained several tongueless individuals who consistently refused food in a manner which suggested that the snakes failed to recognize small mice as prey (John Behler,

Key words: Reptilia, Serpentes, *Vipera*, predation, chemoreception.

curator of Herpetology, NYZP, personal communication). Since no post-mortem data are available on these animals, we have no way of knowing whether or not they exhibited additional complications (e.g., brain damage). Hence, it may not be appropriate to attribute the total absence of feeding behavior entirely to the alingual condition. None-the less, the behavior of these animals is consistent with the first sentence in the above quote from Burghardt (1980).

We here report observations on a congenitally alingual Russell's viper (*Vipera russelli*) from San Diego Zoo. Although feeding behavior in *V. russelli* has not heretofore been studied in great detail, Chiszar et al. (1982a) reported that predatory behavior in several species of *Vipera* is fundamentally similar to that seen in rattlesnakes (see Chiszar & Scudder, 1980, and Chiszar et al., 1982c, for reviews of recent work on rattlesnake predatory behavior). It is probable that: (1) most species of *Vipera* are ambush predators (see Greene, 1982, for a conceptualization of ambush predation), (2) adult rodent prey are released after the envenomating strike, and (3) the snakes then exhibit strike-induced chemosensory searching and trail following (Baumann, 1927, 1929; Dullemeijer, 1961; Golan et al., 1982; Kahmann, 1932; Naulleau, 1965; O'Connell et al., 1982; Wiedemann, 1932). O'Connell et al. (1983) showed that strike-induced chemosensory searching occurs in captive *V. russelli* at San Diego Zoo. However, these investigators found that specimens of *V. russelli* tend to hold small mice (< 15 gm) after striking, whereas rattlesnakes of most species usually release all but neonatal mice. Our experience with the present specimen of *V. russelli* is consistent with that of O'Connell et al. (1983) -- large (but ingestible) rodents are released while small rodents are typically held (see also Chiszar et al., 1983).

The purpose of the present study was to determine if strike-induced chemosensory searching (SICS) occurs in this alingual specimen. Although rate of tongue flicking has been the usual dependent variable in SICS experiments (see Chiszar & Scudder, 1980), it has also been demonstrated that locomotion in snakes is strongly correlated with rate of tongue flicking (Chiszar & Carter, 1975). Moreover, Scudder (1982) showed that treatments which increase or decrease rate of tongue flicking in rattlesnakes have the same effects on locomotion. Hence, the present study recorded rate of locomotion in the alingual *V. russelli* under conditions identical to those of previous SICS experiments.

Method

The specimen of *V. russelli* (San Diego Zoo inventory #381139) was born at Cincinnati Zoo (5/21/81) in a litter of six. The entire litter was loaned to SDZ on 7/3/81 and has been at SDZ ever since. During the summer of 1982, Barbara O'Connell and Robin Greenlee (Dept. of Herpetology, SDZ) were conducting an SICS experiment at SDZ and discovered that the present specimen was alingual (all the littermates were normal and exhibited clear SICS; O'Connell et al., 1983). James Bacon (Curator of Herpetology, SDZ) gave permission for the alingual specimen

to be transported to the University of Colorado for further study. The specimen was transported to Colorado in September, 1982, and was subsequently maintained in a glass terrarium (60 x 30 x 30 cm) at 26 °C (photopase = 0900-1800). The terrarium contained a glass vessel filled with water and a paper floor cover. While at SDZ the snake was fed one dead adult mouse (*Mus musculus*) per week. At Colorado the same feeding schedule has been followed except that live prey have been offered. The snake exhibits no hesitation in envenomating live mice.

On each of three successive weeks (prior to feeding) the snake was observed in two conditions. In the control or no-strike condition, a live mouse was suspended from forceps into the snake's cage and held out of striking range for 3 sec. The mouse was then removed. The experimental condition was exactly like the control except that the mouse was lowered into striking range at the end of 3 sec. The snake struck immediately in each case. When the mouse was not released (twice), forceps were gently applied to the back of the snake's neck. This treatment resulted in immediate release of the prey and the mouse was removed.

The floor of the terrarium was covered by newsprint which was marked into 72 squares, each 5 cm per side.

Beginning 10 min prior to mouse presentations, one or two observers recorded (with hand-held counters) the number of squares through which the snake's head passed (per min). This was regarded as the baseline rate of locomotion. Immediately following removal of the mice, observations were re-initiated and they continued for the next 30 min.

During weeks 1 and 3 the experimental condition was run first and the control was second (2 days later); during week 2 the order of presenting conditions was reversed.

Results

The number of squares transversed by the snake's head is plotted in Figure 1 for each control and each experimental observation. Two observers independently recorded this measure (min-by-min) during the first control session and during each of the experimental sessions. For each of the four sets of paired observations (40 paired scores in each set: 10 baseline min and 30 postpresentation min), we calculated a correlation coefficient representing the degree of agreement between observers. Those correlations were .82, .89, .99, and .98, respectively, indicating strong inter-observer agreement. Hence, two persons recording the present measurement at the same time arrive at very similar values, demonstrating the reliability of this operationalization of locomotion.

For those four sessions where two observers recorded data, means were computed for each min, and these means were used in Figure 1 as well as in the statistical analyses reported below.

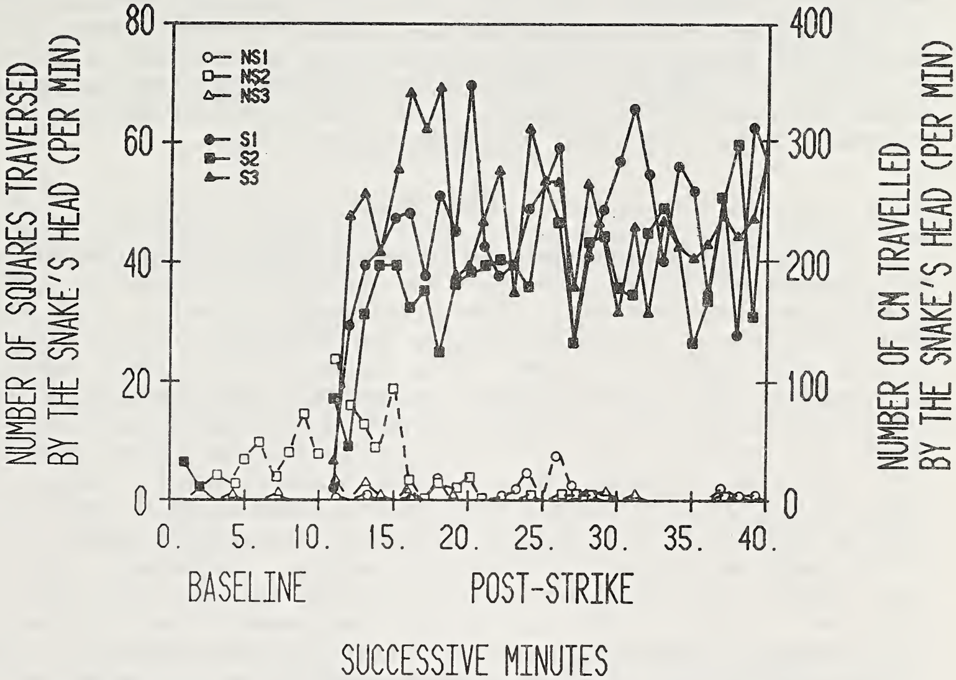

Figure 1. The paper floor cover of the snake's cage was marked into 72 squares (5 xm per side). The left ordinate indicates number of squares through which the snake's head moved (per min). A total of 6 30-min observations were made (3 control and 3 experimental). The snake was also observed for 10 min prior to each control and experimental trial. Hence, the abscissa indicates 10 baseline min and 30 postpresentation min. Each control and experimental run is shown separately to illustrate the replicability of the strike-induced elevation of activity. The right ordinate translates squares traversed into approximate distance traveled (per min) by the snake's head.

Generally the snake was quiescent during baseline observations. Analysis of variance (ANOVA) comparing baseline locomotion with that during min 1-10 post presentation revealed significantly greater elevation of scores after experimental than after control treatments ($F = 37.27$, $df = 1/2$, $P < .05$). Another ANOVA was applied to postpresentation data treating replications, control vs experimental treatments and

the 30 successive postpresentation min as orthogonal factors. The ANOVA revealed a robust difference between the control and experimental treatments ($F = 112.82$, $df = 1/2$, $P < .01$). In fact, this effect accounted for 82% of the variance in postpresentation locomotion scores. The interaction between treatments and successive min was also significant ($F = 3.04$, $df = 29/58$, $P < .01$), reflecting the fact that locomotion scores increased to an asymptotic level after striking whereas scores decreased to baseline after no-strike presentations.

Discussion

The effect of treatments on postpresentation locomotion scores and the interaction between treatments and successive min were very similar in magnitude and duration to effects reported in previous SICS studies which used rate of tongue flicking as the dependent variable (Chiszar et al., 1977, 1982a,b; Scudder, 1982; Scudder et al., 1983; see also Gillingham & Clark, 1981). Hence, we conclude that the present specimen exhibits SICS, and that Jacobson's organs are probably functional both in the initiation of SICS and in analyzing molecules which subsequently enter the mouth (O'Connell et al., 1982; Scudder, 1982). Indeed, as the animal moves about its cage after striking a mouse, it is possible to observe flexions of the lingual musculature and slight jaw openings as if the snake was actually flicking its tongue. Furthermore, when the snake bumped into a dead mouse during feeding sessions, the snake recognized the carcass as food and chemical cues seemed to be involved in this recognition because the snake frequently poked at the carcass with slightly parted jaws as if an attempt was being made to sample molecules. Although this snake seemed slower than normal snakes in the initiation of swallowing, if the rodent carcass was not more than a few cm away the snake always found and eventually swallowed it. These observations suggest that the snake was relying on vomeronasal chemoreception and that at least some chemical cues were transported to Jacobson's orans even without a tongue (see Gillingham & Clark, 1980). This is consistent with the second sentence in the above quotation from Burghardt (1980).

We believe that contacting a rodent carcass located only a few cm away is a very different matter than following a trail left by an envenomated mouse (Golan et al., 1982). Such trails can be up to 600 cm long and they averaged about 200 cm when prairie rattlesnakes envenomated laboratory mice (Estep et al., 1981; see also Brock, 1979). Although we have no data on lengths of trails left by rodents after envenomation by *V. russelli*, it seems probable that such trails will be comparable in length to those described by Estep et al. (1981). Accordingly, our next steps shall be (1) to measure the lengths of trails left by mice envenomated by this *V. russelli*, and (2) to examine the extent to which this snake can follow such trails. The hypothesis is offered that this alingual specimen will not be able to follow trails since this behavior probably requires a normal ability to transport nonvolatile chemicals to Jacobson's organs (Burghardt, 1966, 1980; Kubie & Halpern, 1978; Sheffield et al., 1968). On the other hand, if nonvolatile materials are

presented on mandibulatable objects (e.g., cotton swabs), then the snake might be able to follow a trail enhanced by a row of such "odoriferous posts". Such results would confirm the functional character of the present animal's Jacobson's organs and they would add to the growing body of data regarding the importance of the ophidian tongue for transporting (nonvolatile) chemical cues to Jacobson's organs.

Acknowledgement

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Frank L. Slavens

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TWO NEW SPECIES OF THE LIZARD GENUS *SCELOPORUS* (REPTILIA, SAURIA, IGUANIDAE) FROM THE AJUSCO AND OCUILAN SIERRAS, MEXICO

Guillermo Lara-Gongora

Abstract

Two populations of *Sceloporus* previously referred to *grammicus* are named as distinct species: *S. anahuacus* sp. nov., and *S. palaciosi* sp. nov. Both taxa are more closely related to *S. grammicus microlepidotus* than to each other.

The main morphological differences between *S. anahuacus* and *S. palaciosi* are, respectively: scale rows around body $\bar{X}$ 72.48 and 67.37; nuchals $\bar{X}$ 11.92 and 9.97; $\bar{X}$ SVL (mm) 49.33 and 52.98; max SVL 54 and 61; and dorsal color pattern.

The main differences from *S. grammicus microlepidotus* are: lesser length, more conspicuous coloration, and a tendency toward fewer dorsals, ventrals, scales around body and femoral pores. These taxa are discussed in relation to the karyotypes described by Hall and Selander (1973) in the *grammicus* complex.

The taxonomic concepts of the *Sceloporus grammicus* group that were developed by Smith in 1939 (1939: 177-199) and expanded in 1950 by Smith and Taylor (1950: 119-121) have been extensively challenged and partially modified in recent years, particularly by karyological studies pioneered by Hall (as reported in Hall, 1972; Hall and Selander, 1973; Hall, 1980) and extended by Sites and Dixon (1981). Two taxa have also been added to the group (*S. shannonorum* Langebartel, 1959, fide Webb, 1969; *S. grammicus tamaulipensis* Sites and Dixon, 1981). The assemblage as a whole has not been reviewed in detail in the light of these recent discoveries, but it is apparent that a great deal of effort will be required to secure a definitive understanding of its systematics. The new taxa here proposed are a contribution to the ultimate resolution of the puzzling problems posed by this widely distributed, abundant complex.

The original material on which this study is based includes 18 specimens taken in April, 1976, in the Sierra del Ajusco, Distrito

Federal; 35 taken in September, 1976, in the Lagunas de Zempoala National Park, state of Mexico; and numerous examples taken in Mexico City. Subsequently numerous other specimens have been collected. All were preserved as prescribed by Knudsen (1966), and have been deposited in the Coleccion Herpetologica, Museo de Zoologia Alfonso L. Herrera, Facultad de Ciencias, Universidad Nacional Autonoma de Mexico, Distrito Federal, to which the museum acronym MZHRL alludes.

Figure 1. Holotype of *Sceloporus anahuacus*, adult male from Cerro del Coyote, Monte Alegre, 3400 m.

Sceloporus anahuacus sp. nov.

(Figure 1)

Holotype

MZHRL 0544, adult male from Cerro del Coyote, Monte Alegre, Sierra del Ajusco, Distrito Federal, 3400 m, collected by the author, Oscar Sanchez Herrera and Oscar Flores Villela.

Paratypes

MZHRL 0543 (series) from same locality and collectors; MZHRL 0550 (series) from Estacion Experimental de Chapingo of the Instituto Politecnico Nacional, Parque Nacional Zoquiapan, state of Mexico, collected by the author (Figure 2).

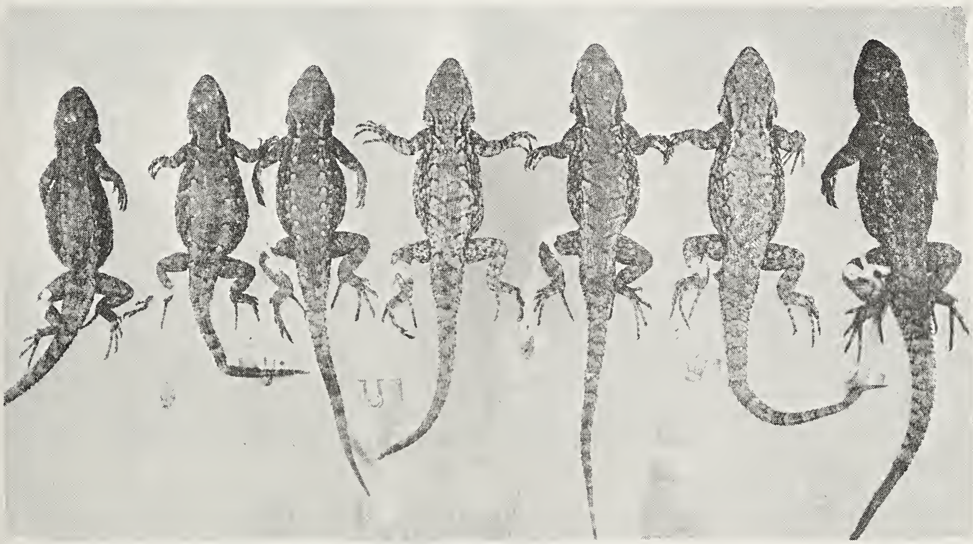

Figure 2. Paratypes of *Sceloporus anahuacus*, mixed sexes and localities (see text).

Diagnosis

A small species, snout-vent length (SVL) of adults $\bar{X}$ 49.33 mm, max. 54 mm; ratio of SVL-HL (head length) in adult females $\bar{X}$ 0.254; dorsal scales 65 - 83 ($\bar{X}$ 75.4); ventral scales 44 - 63 ($\bar{X}$ 52); femoral pore series moderately separated medially, 14 - 18 in each series ($\bar{X}$ 15.5); 2 frontoparietals separated each other; 4 rows of lorilabials; outer rows of supraoculars in 4 complete series, temporals $\bar{X}$ 9.37; nuchals $\bar{X}$ 11.92; head scales smooth but pitted.

Description of Holotype

SVL 49 mm, total length (TL) 109 mm; rostral slightly subrectangular; 4 small postrostrals bordering rostral posteriorly; nasal opening central and occupying almost entire nasal scale, approximately 3 times size of any postrostral; 1 pair of internasals separating medially both nasals; 3 prefrontals bordering frontal anteriorly and with it forming a rhomboid; 1-1 subnasals; 6-6 supralabials from rostral to rictus oris; 2-2 canthals, the first on canthus rostralis, contacting subnasal; 1-1 loreals, subcircular; lorilabials in 2 complete series; 1-1 preoculars, entire; 1-1 suboculars, entire; 2-2 keeled postoculars, enlarged in relation to the adjacent scales, following subocular; 8-8 infralabials, counting from mental scale to rictus oris; 8-8 keeled temporals vertically from supralabials to parietals; frontal transversely divided, in contact with interparietal; 2 frontoparietals, separated medially by contact of frontal and interparietal; interparietal subpentagonal, slightly concave, approximately 5 times size of posterior section of frontal; 2-2 parietals, second pair 3 times larger than first; inner supraoculars enlarged, 7-7; outer supraoculars in 3 series of small scales, 2 complete and 1 incomplete series between inner supraoculars and superciliaries; supraocular semicircles incomplete; head lined with small granules; 10 small nuchal scales bordering parietals and interparietal posteriorly.

Mental pentagonal; 2-2 enlarged postmentals; notched, smooth gular scales in longitudinal parallel series; outer rows of mentolabial scales 1-2; inner rows of mentolabials 2-3; 1 genial; auricular lobules 4-4 on anterior border of ear opening.

Lateral scales on trunk small, mucronate, in vertical and oblique parallel series; dorsal scales small, mucronate, keeled, irregularly placed, in longitudinal parallel series, in 68 rows counting from interparietal to an imaginary transverse line connecting posterior margins of insertions of hind limbs; ventral scales notched, smooth, in oblique series coming to middle of venter, in 48 rows; no postfemoral dermal pocket; 22-24 lamellae under fourth toe; no preanal folds; 29 (15-14) femoral pores; preanal scales notched, smooth; dorsal caudal scales large, mucronate, strongly keeled, in longitudinal parallel series and in transverse whorls; ventral caudal scales large, strongly mucronate, keeled, in longitudinal series and in transverse whorls.

Coloration

Dorsum light brownish or grayish, with 5 pairs of dark transverse lines, separated middorsally, the first pair forming a narrow nuchal collar; dorsal coloration well differentiated from lateral coloration, latter darker and with conspicuous dark and light reticulations as well as light blue scales isolated in light regions. Light blue lateroventral patches with dark medial border separated by a medial light stripe, not reaching axilla; pectoral region whitish; rear gular region transected by a black band 3 scale rows in width.

Head brownish or grayish, with few dark spots; cephalic plates light brown; a dark lateral line crossing head from eye to anterior border of ear opening; a lateral dark line from nasal opening to parietals, crossing eye; mental region yellowish.

Tail dark brown dorsally, with dark transverse bands dimly evident; tail yellowish below. Conspicuous dark and light bands crossing anterior limbs, less evident on hind limbs.

Range

Higher parts of the Sierras bordering southern portions of the Altiplanicie Mexicana. Specific localities are: DISTRITO FEDERAL: Monte Alegre, Cerro del Coyote (3400 m) and Cerro de los Gavilanes (3300-3400 m); Llanos de la Cantimplora (3200 m); Santa Rosa Xochiac (2800-2950 m). MEXICO: Parque Nacional Zoquiapan, Estacion Experimental de Chapingo (3150 m), Cerro Telapon, Cerro Potrero, Canada del Quesero (3100-3200 m), extreme northern Llano Grande (3150 m), between Rio Frio and Llano del Guarda (3100 m); San Juan Zitlaltepec (2800 m).

Habitat and Habits

This species inhabits primarily open, relatively dry pine forests, from 2800 m to tree line in higher peaks of the Sierra Nevada, where bunchgrasses proliferate on the ground. It has also been found in pine-oak forests or *Pinus-Alnus* associations in the Sierra Nevada (Cerro Telapon, and Cerro Portero, near Llano Grande, state of Mexico), but always is associated with bunchgrass as the herbaceous stratum of the forest. Most of the 30 specimens of the type series were collected on decayed logs or stumps; less than 10% were collected on rocks. At the type locality, *S. anahuacus* inhabits a mainly very open pine forest (*Pinus montezumae*) with bunchgrass (*Mullembergia*) forming the herbaceous stratum. Lizards are present in the fir forest (*Abies religiosa*) only in the ecotone with pine forest or where the forest is disturbed and with an abundance of decayed trees on the ground. *S. anahuacus* is an abundant organism where it

occurs, and can be easily be found under the bark of dead trees during the first hours of the day, before they are warmed by the sun, or on cloudy or cold days. As the trees are warmed the lizards emerge to bask. They are indicators of forest disruption since they proliferate in areas of intense commercial clearing of recovering burns, or of any other kind of disturbance that creates a more open forest structure.

Etymology

The name *anahuacus* (Latinized from the nahuatl word Anahuac) is applied in reference to the known distribution of this species, i.e., the high mountains bordering the southern portion of the Meseta del Anahuac.

Figure 3. Holotype of *Sceloporus palaciosi*, adult male from Cerro del Caballete, Parque Nacional Miguel Hidalgo (Lagunas de Zempoala), 3000 m.

Sceloporus palaciosi sp. nov.

(Figure 3)

Holotype

MZHRL 0546, adult male from Cerro del Caballete, second lake, Parque Nacional Lagunas de Zempoala, Sierra de Ocuilan, state of Mexico, 300 m; Oscar Flores Villela collector.

Paratypes

MZHRL 0548 (series) from the same locality and collector; MZHRL 0547 (series) from El Capulin, state of Mexico, 3150-3300 m, collected by the author; MZHRL 0545 (series) from Cerro del Coyote, Monte Alegre, Sierra del Ajusco, D.F., 3650 m, collected by the author, Oscar Flores Villela and Jaime Marcelo Aranda-Sanchez. (Figure 4)

Figure 4. Paratypes of *Sceloporus palaciosi*, mixed sexes and localities (see text).

Diagnosis

A small species, SVL of adults $\bar{X}$ 53 mm, max. 61 mm; ratio of SVL-HL in adult females 0.244; dorsal scales 67 - 82 ($\bar{X}$ 73); ventral scales 46 - 65 ($\bar{X}$ 52); femoral pore series moderately separated medially, on each side 13 to 20 ($\bar{X}$ 16); 2 frontoparietals separated each other; 4 rows of lorilabials, 2 complete and 2 incomplete series; outer rows of supraoculars in 4 complete series; temporals $\bar{X}$ 11, nuchals $\bar{X}$ 10; head scales pitted.

Description of Holotype

SVL 54 mm, TL 129 mm; rostral slightly subrectangular; 4 small postrostrals bordering rostral posteriorly; nasal openings central, occupying almost all of nasal; internasals in 2 irregular pairs; 3 prefrontals bordering frontal anteriorly, forming with it a rhomboid; 1-1 subnasals; 8-8 supralabials; 2-2 canthals, the first on canthus rostralis; 1-1 loreals; lorilabials in 4 horizontal series, 2 complete and 2 incomplete; 1-1 preoculars, entire; 1-1 complete suboculars; 2-2 enlarged and keeled postoculars following subocular; 9-9 infralabials; 10-11 keeled temporals; frontal transversely divided, posterior section in contact with interparietal; 2 frontoparietals separated from each other by contact of interparietal and frontal; interparietal subtriangular, slightly concave; 2-2 parietals; inner series of supraoculars enlarged, 8-7; outer supraoculars small, in 4 series, 2 complete and 2 incomplete; supraocular semicircles complete; lateral nuchal pocket moderately deep with granules in its interior; 7 nuchals bordering interparietal and parietals posteriorly; cephalic scales, smooth, shiny, most "pitted"; no gular fold.

Mental pentagonal; 2 pairs of enlarged postmentals; gular scales smooth, notched, in longitudinal parallel series; inner mentolabials in 2-3 series; outer mentolabials in 1-2 series, 2 small genial scales; 5-5 auricular lobules on anterior border of ear opening.

Dorsal scales mucronate, keeled, in 70 longitudinally parallel, irregular series, the scales similar to laterals; ventrals smooth, notched, toothed, in parallel, obliquely opposed series converging midventrally, in 60 transverse rows; 1 pair of enlarged, smooth, notched, concave postanal scales; posterior thigh scales tubercular-granular, very small compared with preanal scales; dorsal caudal scales enlarged, strongly mucronate, keeled, in parallel longitudinal series and transverse whorls; ventral caudal scales enlarged, mucronate, strongly keeled, in parallel longitudinal series and transverse whorls; no dermal postfemoral pocket; 23-22 lamellae under fourth toe; no preanal folds; femoral pore series conspicuous, moderately separated medially, 18-17.

Coloration

Dorsal coloration grayish or brownish, with 4 pairs of dark, transverse dorsolateral lines converging to center of dorsum, slightly interrupted medially, first pair forming a narrow nuchal collar; lateral coloration darker, with black reticulations on a light brown background; ventrolateral patches light blue, bordered medially by a white zone and a paramedian, longitudinal black line, not reaching posterior insertion of fore limbs; pectoral region whitish-grayish; gular region whitish with grayish spots and isolated blue scales distributed in a regular pattern; head brownish, with a dark lateral band crossing from eye to anterior border of ear opening; dorsal surfaces of tail with transverse, conspicuous, alternating, light and dark bands, continuous ventrally; limbs with dimly evident, transverse, alternating light and dark bands.

Range

Lower to higher elevations of the Ajusco, Ocuilan, and Nevada Sierras, from 2700 m to tree line. This species probably is widely distributed in Mexico in the higher Sierras Madre. Definite records are: DISTRITO FEDERAL: Monte Alegre, Cerro del Coyote (3650 m); Santa Rosa Xochiac (2800 m); Heroes de Padierna (2800 m). MEXICO: El Capulin (3050-3400 m); Parque Nacional Zoquiapan, Cerro Telapan, Canada del Quesero (3100-3300 m); extreme southern Llano Grande (3100 m); Parque Nacional Miguel Hidalgo, 4th lake and Lake Quila (2950 m); San Rafael (3000 m); Nevado de Toluca (4400 m). MICHOACAN: Villa de Allende (2800 m). MORELOS: approximately 4#km. N Fierro del Toro (3000 m).

Habitat and Habits

This species prefers dense humid forests of *Abies religiosa*, and mixed forest (with arboreal elements of various species of the genera *Pinus, Abies, Quercus, Cupressus, Alnus* and *Arbutus*); it does not occur in dry and open pine forests lacking a dense herbaceous stratum. It can, nevertheless, be found in oak-pine forests that are drier than fir forests, sometimes with bunchgrass. Elevational limits are from 2750 to 4400 m. Most specimens from the type locality and all obtained in the Capulin and Rio Frio areas, in the state of Mexico, were found on decayed logs, stumps, or dead erect trees in the mixed pine forests of *Pinus montezumae* and *Pinus hartwegii-Alnus jorullensis* association.

Etymology

The specific name is a patronym for Dn. Prococo Palacios, a very good friend from the Comunidad Rancho El Capulin who has been very kind and helpful to us in many ways throughout our study.

Key to Lizards of the *grammicus* Complex in the Environs of the Southern Valley of Mexico

1. a. Mountain regions (altitudes of 2700 m and greater)---------------2

   b. Valley regions (altitudes below 2700 m)---*grammicus microlepidotus*

2. a. Dorsal coloration of 6 (5-7) parallel transverse lines on a light background, more or less continuous with the dark and light tail rings; SVL never exceeding 54 mm; primarily in open pine forests with bunchgrass, from 2800 m to tree line---------------*anahuacus*

   b. Characteristics variable---3

3. a. Dorsal aspect "lichenoid"; 4 curved lines generally fused at mid-back, the left lines higher than the right ones; head coloration not much different from that of body, scales accentuated; dorsal scales 67-82, $\bar{X}$ 73 (12.64% more than 78); femoral pores $\bar{X}$ 16; max. SVL 63 mm; humid fir or mixed forests from 2700 to 4400 m--------- ---*palaciosi*

   b. Lines not fused medially, not making a "lichenoid" pattern; head light, well differentiated from dorsal coloration; scales accentuated; dorsal scales 72-96, $\bar{X}$ 82 (16% less than 79); femoral pores $\bar{X}$ 18; arboreal and saxicolous; to 73 mm SVL; restricted to vicinity of human habitation; to not over 3000 m------*grammicus microlepidotus*

Discussion

In additional to the morphological and ecological differences already noted between *S. grammicus microlepidotus*, *S. palaciosi* and *S. anahuacus* (Table 1, Figure 5), there is a strong correlation between these taxa and the geographical distribution of karyotype variants recorded by Hall (1972) and Hall and Selander (1973) within the *grammicus* complex, especially in the Valley of Mexico.

TABLE 1

MERISTIC DATA ON THREE TAXA OF *SCELOPORUS*[1]

	anahuacus				*anahuacus* X *palaciosi*				*palaciosi*					*microlepidotus*	
Locality	1	2	3	4	10	11	12	13	5	6	7	8	9	14	15
Dorsal scales	65-83 (75.16)	70-81 (75.14)	75-79 (77.00)	70-77 (74.33)	71-76 (73.33)	69-78 (75.16)	63-77 (70.16)	69-75 (71.40)	68-78 (73.51)	72-82 (76.59)	68-80 (74.40)	67-74 (70.80)	70-73 (72.00)	72-92 (81.75)	76-96 (83.50)
Ventral scales	48-63 (55.61)	44-53 (49.00)	49-55 (52.00)	50-52 (51.33)	44-54 (49.33)	51-55 (53.00)	46-53 (49.00)	47-56 (50.20)	54-65 (59.17)	48-58 (53.40)	46-61 (52.45)	46-52 (48.40)	47-51 (49.33)	51-62 (56.00)	50-63 (56.82)
Scales around body		67-80 (72.28)	72-73 (72.50)	68-76 (72.66)	67-76 (72.66)	66-79 (71.33)	61-71 (65.83)	66-77 (71.00)		65-75 (68.80)	59-73 (67.22)	58-75 (66.20)	59-67 (63.66)	69-76 (71.50)	66-86 (73.58)
Temporal scales	(8.70)	8-10 (9.28)	9-10 (9.50)	9-12 (10.00)	8-11 (9.33)	8-12 (8.83)	10-13 (10.91)	10-13 (11.11)	9-13 (10.45)	9-12 (10.70)	8-14 (10.36)	9-12 (10.70)	9-11 (10.00)	9-12 (10.25)	9-13 (10.82)
Nuchal scales	(11.80)	10-13 (11.57)	13-13 (13.00)	10-14 (11.33)	8-10 (9.00)	8-11 (9.33)	10-14 (12.16)	9-13 (10.60)	5-12 (7.50)	8-12 (10.50)	7-13 (9.86)	8-10 (9.40)	11-13 (12.00)	10-13 (11.75)	10-16 (12.05)
Femoral pores	(15.36)	14-18 (15.14)	16-17 (16.25)	14-16 (15.16)	16-19 (16.66)	13-16 (14.75)	13-17 (14.66)	15-18 (15.90)	13-20 (15.99)	14-18 (15.60)	14-19 (16.26)	14-17 (15.60)	16-17 (16.83)	18-20 (18.68)	15-21 (17.35)
Ratio of head length/SVL length	.226-.255 (.238)	.269-.274 (.271)				.254-.259 (.257)			(.250)	.226-.264 (.243)	.228-.254 (.240)	.250-.274 (.262)		.238-.260 (.251)	.211-.279 (.251)
Supralabial scales	5-8 (7.15)	6-9 (7.28)	7-7 (7.00)	7-8 (7.17)	6-8 (7.00)	6-9 (7.16)	7-7 (7.00)	6-8 (6.90)	5-9 (6.95)	6-8 (7.10)	6-8 (7.04)	7-9 (7.10)	6-7 (6.83)	6-8 (6.93)	6-9 (7.73)
Infralabial scales	7-10 (8.70)	8-10 (8.92)	8-9 (8.25)	8-9 (8.50)	8-10 (9.00)	8-10 (8.91)	8-10 (8.91)	8-11 (9.00)	8-11 (9.00)	7-10 (9.29)	7-11 (9.20)	8-10 (9.10)	8-10 (8.66)	7-10 (8.37)	8-11 (9.75)
Auricular scales	2-5 (3.60)	4-7 (5.28)	5-6 (5.25)	6-7 (5.66)	3-5 (4.33)	4-7 (5.16)	4-6 (4.75)	3-6 (5.40)	2-5 (4.00)	4-8 (5.50)	3-7 (4.66)	3-6 (4.60)	4-5 (4.66)	3-7 (4.56)	3-8 (6.05)
Lamellae under fourth toe	(21.08)	20-24 (21.42)	20-24 (21.75)	20-21 (20.16)	19-24 (21.33)	20-23 (21.33)	20-22 (20.91)	20-23 (21.40)	18-26 (22.36)	20-24 (21.74)	20-25 (22.04)	19-23 (20.80)	21-24 (22.66)	20-24 (23.06)	18-24 (20.85)
Supraocular scales	5-9 (7.20)	7-10 (8.07)	9-10 (9.25)	7-8 (7.50)	8-10 (8.33)	7-9 (8.16)	6-10 (8.08)	7-9 (7.60)	6-7 (8.86)	6-9 (6.40)		6-9 (7.70)	7-9 (7.83)	7-10 (8.18)	7-10 (8.05)
SVL (adults only) (mm)	(46.50)	(52.16)				(56.4)			(51.72)	(53.40)	(55.31)	(51.50)		(60.80)	(63.43)
Maximum SVL mm	54	54			56	60	54	51	61	61	59	52		67	70
Elevation, m	3450-3500		3150	3100	3400	3150-3200	3150-3200	3150	2900-3100	3000-3200	3600-3650	3300-3400	3200-3300	2950-3000	
n=	18	7	2	3	3	6	6	5	35	15	22	8	6	8	17

[1] Numbered localities are as follows: (1) Monte Alegre, D.F.; (2) Estacion Experimental de Chapingo, Zoquiapan, Mexico; (3) extreme northeastern Llano Grande, Mexico; (4) between Llano Grande and Rio Frio, Mexico; (5) Zempoala, Mexico; (6) El Capulin, Mexico; (7) Monte Alegre, D.F.; (8) 500 m W Canada del Quesero, E slope Cerro Telapon, Zoquiapan, Mexico; (9) extreme southern Llano Grande, Mexico; (10) Paso de Cortes, Popocatepetl, Mexico; (11) 50 m W Canada del Quesero, E slope Cerro Telapon, Zoquiapan, Mexico; (12) 50 m E Canada del Quesero, W slope Cerro Telapon, Zoquiapan, Mexico; (13) Canada Quesero, Zoquiapan, Mexico; (14) San Miguel Ajusco, D.F.; (15) several localities in Mexico City. Means are given in parentheses.

Figure 5. Comparison between *S. anahuacus* (left), *S. grammicus microlepidotus* (center), and *S. palaciosi* (right). All adult male topotypes.

The geographical distributions of Hall's standard, fission 6, and polymorphic-1 karyotypes are strongly correlated with the distributions here recorded for *grammicus microlepidotus*, *palaciosi* and *anahuacus*, respectively. This is especially true for the Rio Frio study area where I collected at precisely the same localities as Hall. I assume that the constancy of the particular phenotypes called here *anahuacus* and *palaciosi*, in their expression and geographical and ecological distribution, is due to correlation with distinctive genotypes: *palaciosi* with the fission-6 karyotype, and *anahuacus* with polymorphic-1 karyotype.

Gunther's (1890: 72, pl. 32, fig. C) description of *S. rubriventris* makes reference to the conspicuous and characteristic "orange belly patches" in adult females, as in both *anahuacus* and *palaciosi*. After reviewing his data I agree with Smith (1950) in placing *rubriventris* as a synonym of

S. grammicus grammicus, for it has no relationship with *palaciosi* or *anahuacus*, either at the ecological or the morphological level.

The population complex long called *S. grammicus microlepidotus* as revealed by Hall's papers and by the present study is a nomenclatural nightmare because of the uncertainty of application of early names. In reality *S. g. microlepidotus* is a nomen dubium not clearly applicable to any one of the recognized taxa of the *grammicus* group. Until the types are reexamined (they are available in the Berlin Museum), the least disturbing and most probably correct allocation of the name *microlepidotus* for the time being is to the populations of the Valley of Mexico (in its lower parts), around Mexico City, where Deppe most likely obtained his samples. These populations are apparently represented by the standard karyotype of Hall, and therefore the distribution of *S. grammicus microlepidotus* corresponds with the distribution stated by Hall for the standard karyotype.

Finally, the phenotypic "intermediate" specimens obtained at the Rio Frio area, and at Paso de Cortes on Popocatepetl, are considered as hybrids and not intergrades between subspecies of the same species, chiefly on the basis of karyological incompatibility stated by Hall. Further data are necessary on both phenotypic and genotypic characters to arrive at definitive conclusions.

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PREDATORY BEHAVIOR IN A CONGENITALLY ALINGUAL RUSSELL'S VIPER (*Vipera russelli*). 2. TRAIL-FOLLOWING BEHAVIOR

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Abstract

A congentially tongueless Russell's viper (*Vipera russelli*, 20 months old, San Diego Zoo inventory #381139), was exposed to rodent trails (150 cm long). Trail-following behavior did not occur if the snake had not struck a mouse just prior to the trailing tests. However, when this *V. russelli* was exposed to an odoriferous trail just after striking a mouse, the snake spent significantly more time in contact with the trail than would be expected on the basis of chance. Hence, the present results indicate either that nasal chemoreception and volatile molecules were involved in trail-following behavior or that molecules were transported to the vomeronasal organs through a non-lingual mechanism.

A previous report (Carr et al., 1982) indicated that striking a live rodent activated searching behavior in a congenitally tongueless specimen of *Vipera russelli*. Except for the absence of post-strike tongue flicking, this snake's searching behavior was topographically similar to strike-induced chemosensory searching (SICS) seen in many viperid species (Chiszar et al., 1982 a,b; Chiszar & Scudder, 1980; Chiszar et al., 1983), including *V. russelli* (O'Connell et al., 1983). Accordingly, Carr et al. (1982) hypothesized that the tongueless specimen had functional vomeronasal organs and that some chemical cues were transported to these organs through an extra-lingual route (see Burghardt, 1970, 1980 for reviews of chemical perception in reptiles; see also Gillingham & Clark, 1981).

The present study was designed to measure trail-following behavior in the alingual *V. russelli*. This snake was able to find rodent carcasses located only a few cm away from its head, and delivery of a predatory strike facilitated this process (Carr et al., 1982). Nonetheless, following a rodent's chemical trail would appear to be a more demanding task which requires a normal ability to transport nonvolatile chemicals to Jacobson's organs. Hence, it was predicted (Carr et al., 1982) that the alingual specimen would not be able to follow such trails (cf., Burghardt & Pruitt, 1975; Kubie & Halpern, 1979; Wilde, 1938).

Experiment I

It was decided first to determine the distance traveled by mice after envenomation by this specimen of *V. russelli*. Trails of at least

this length would be used in subsequent tests so that we could infer whether or not the snake can follow a trail of the length it might actually encounter under natural conditions.

Method

Procedures of Estep et al. (1981) and Radcliffe et al. (1983) were used in this study. The apparatus was a plywood box (100 x 100 x 90cm), with a floor marked into 36 16.5 cm squares. A mouse (*Mus musculus*, C3H, 20-22 gm, male) was suspended by forceps into the snake's home cage and moved into striking range. Immediately after envenomation the mouse was placed into the apparatus and we recorded: (1) latency (sec) to become immobile, (2) latency to die (defined as cessation of visible respiratory contractions, and (3) number of squares traversed during each successive 15-sec period until immobilization. Less than 3 sec was required to transfer the mouse from the site of envenomation to the nearby plywood box.

The snake (San Diego Zoo inventory #381139) was 20 months old at the start of this study and had been loaned to the University of Colorado (Sept., 1982) by Dr. James Bacon (Curator of Herpetology, SDZ). See Carr et al. (1982) for additional details concerning this animal's history and current maintenance conditions. One live mouse was offered to the snake each week for five weeks. These mice were observed as described above before they were placed back into the snake's home cage for ingestion.

Results

The mean number of sec prior to immobilization of prey was 42.4 (SEM=19.6), and the mean number of sec prior to death was 137.4 (SEM=52.5). The difference between these means ($t=2.60$, $df=4$, $.10>P>.05$) indicated that venom had detectible effects on rodent mobility considerably before the rodents died (Estep et al., 1981; Hayashi et al., 1982). The mean number of squares traversed by the envenomated mice in the plywood box was 8.4 (SEM=3.50). Multiplying this value by 16.5 gives the approximate mean distance traveled prior to immobilization, 138.6 cm (SEM=57.75; range=16.5-330.0).

Discussion

The mean latencies to immobilization and to death for mice envenomated by this *V. russelli* were shorter than values reported by Estep et al. (1981) for male C3H mice envenomated by prairie rattlesnakes (*Crotalus viridis*; mean latency to immobilization was 54.7 sec, mean latency to die was 240.1 sec). However, since latency scores exhibit considerable variability, and since only one specimen of *V. russelli* has so far been studied, it would be premature to claim these differences to be significant.

The mean distance traveled by the present mice after envenomation provides an indication of the extent of the trailing task that would confront this snake under natural conditions. Experiment II used slightly longer trails, partly to permit comparison with our rattlesnake data (Golan et al., 1982; Chiszar et al., 1983) and partly because the value of 138.6 cm is an underestimate since several sec were required to transport the envenomated mouse to the plywood box.

Experiment II

Method

The *V. russelli* was placed into a small compartment (60 x 66 x 81cm) at one side of a large wooden pen (180 x 66 x 81cm). The remainder of the pen constituted a large compartment. The two compartments were separated by an opaque partition containing a guillotine door (Chiszar et al., 1983; Golan et al., 1982). A heavy meandering line 150 cm long was drawn on the paper floor cover through the center of the large compartment from the guillotine door to a rock at the opposite side of the pen. Two fine parallel lines, each 2 cm from the heavy one, were also drawn. A dead mouse was dragged along the heavy line, and placed behind the rock. Then the guillotine door was raised, allowing the snake into the large compartment. We recorded the amount of time that the snake's head was positioned between the fine lines from the time the door was opened until the snake found (i.e., grasped) the mouse, or for a maximum of 20 min. We also recorded the amount of time that the snake was in motion by activating a stopwatch whenever the snake was moving. Since the front half of the body could be in motion while the rear half was still, we independently recorded each half of the body with separate stopwatches. Prior to opening the guillotine door, the snake was allowed to strike a live mouse suspended into the cage from long forceps, or the snake was simply exposed for 15 sec to a live mouse held out of striking range. The first condition was called "strike/trail-present" (S-T); the second was called "no-strike/trail-present" (NS-T). The snake was also observed in a third condition: "strike/no-trail" (S-NT). Here the snake was allowed to strike a live mouse prior to the opening of the guillotine door; but, no mouse had been dragged along the heavy line. Hence, no chemical trail was present in the large compartment (although a dead mouse was located behind the rock, as usual).

All dead mice that were placed behind the rock had been killed by cervical dislocation. Stimulus mice (i.e., those presented to the snake at the start of each trail) were withdrawn and discarded immediately after 15 sec (in NS trials) or after being struck (S trials).

The snake was observed once per week for nine weeks. Each condition (S-T); NS-T; S-NT) was replicated three times, and order of presenting the three conditions was randomized within each successive three week period. The snake ingested one mouse per week (at the end of each trial).

Results

For each trial we calculated the percent of time the snake's head was situated between the fine lines, beginning from the moment the snake first touched the heavy line (this corresponded to the moment the snake's head passed through the guillotine doorway) and ending after 20 min or when the snake grasped the mouse (see Table I, row A). Latency to locate the mouse is also presented in Table I (row B). Finally, the percent of time that the snake was

TABLE I

Means for each of the temporal measures recorded in Experiment II are shown for each of the three conditions

Measure	Condition: S-T	S-NT	NS-T	F ratio df=2/6
A. % of time on trail	29.23[a]	11.56[b]	4.72[b]	12.12**
B. Latency to locate mouse (sec)	328.00[a]	368.30[a]	1164.60[b]	25.52**
C. % of time front half of snake's body in motion	77.27[a]	81.58[a]	25.40[b]	8.64*
D. % of time rear half of snake's body in motion	39.81[a]	39.18[a]	5.51[b]	8.36*

Means (within a row) having the same superscript do not differ significantly by Newman-Keuls test (.05).

* p<.05
**p<.01

in motion is shown in Table I (separate entries are given for front half and rear half of the body; rows C and D).

Analysis of variance applied to percent of time that the snake's head was situated between fine lines revealed significant trailing behavior only in condition S-T (inferential statistics are shown in last column of Table I). To supplement the information in Table I, it can be pointed out that the area constituting the trail occupied 14% of the total area of the floor in the large compartment of the pen. Comparison of the

mean time on trail (i.e., mean percent of time the snake's head was situated between the fine lines) with chance expectation of 14% revealed significant deviation from chance only in condition S-T ($t=5.33$, $df=2$, $P<.05$). In condition S-NT the snake did not follow the lines containing no mouse odor ($t=0.42$). Instead, the snake searched more or less randomly in the large compartment. In condition NS-T the snake did not follow the odor trail when a strike had not previously been delivered to a mouse. In fact, in condition NS-T the snake rarely moved into the large compartment, and when it did so it spent considerably less time on the trail than expected on the basis of chance ($t=-2.44$, $df=2$, $.20>P>.10$), reflecting the occurrence of thigmotaxic behavior in the absence of predatory strikes. Hence, a predatory strike not only induced SICS and trailing behavior, a strike also overrode a strong thigmotaxic predisposition which would cause the snake to move with its body in contact with walls and, therefore, well away from the centrally-placed trail.

Latency to locate the mouse behind the rock was significantly shorter after striking prey than after NS presentations. In fact, carcasses were not discovered in two of the three NS trials. However, the means for conditions S-T and S-NT did not differ. Although trailing occurred in condition S-T, this behavior was not efficient enough to allow the snake to locate the rodent carcass more quickly than could be accomplished by the random searching seen in condition S-NT.

Relative inactivity after NS presentations can also be seen in the last two rows of Table I. The snake was active for a few minutes after the initial stimulus-mouse presentation, but the snake then usually coiled its body and discontinued movement, giving rise to low scores for both locomotion measures.

In conditions S-T and S-NT, on the other hand, the initial post-strike period was invariably characterized by sweeping motions during which the snake's head moved in wide arcs. However, the snake's centroid remained fixed. (That is, only the front part of the body moved; the rear half remained more or less still. Hence the snake's location did not change much during the initial period.) Once the snake contacted the trail (condition S-T), the rear half of the body would be drawn slowly forward along the trail while the head continued to execute sweeping arcs across the trail. Accordingly, progression always involved much more activity by the front half of the body than by the rear half. Frequently progression ceased but the front half of the body continued executing wide arcs. Probably the most interesting aspect of the two locomotion measures is the fact that the means (Table I, rows C and D) did not differ between conditions S-T and S-NT, indicating that post-strike locomotion has a topographically fixed character which does not vary depending upon the presence or absence of a chemical trail (Chiszar et al., 1977; Chiszar & Scudder, 1980; Golan et al., 1982; Scudder et al., 1983).

General Discussion

The specimen of *V. russelli* showed little activity and no trailing behavior after no-strike presentation of live mice. However, locomotion was clearly increased after striking prey, agreeing with results of Carr et al. (1982). When a chemical trail was available in the post-strike environment, the snake was able to detect and follow it. If tests were conducted in a larger environment, it seems reasonable to expect that carcasses would be more rapidly discovered in condition S-T than in condition S-NT. Rapid discovery of carcasses in the present S-NT condition resulted from strike-induced elevation of general activity. Although the snake's searching behavior was randomly directed in condition S-NT, the relatively small area of the experimental compartment allowed the snake to contact the carcass fairly soon by chance (Golan et al., 1982).

That trailing behavior occurred in condition S-T is the most important result of this study. Yet, the precision of the snake's trailing behavior in condition S-T was certainly not impressive. We currently have no data on trailing behavior of normal (i.e., control) *V. russelli*. However, we have a great deal of data for rattlesnakes, and these animals are far better at following trails than the present *V. russelli*. Once a rattlesnake makes initial contact with a rodent trail in conditions analogous to the present S-T, the rattlesnake's head will usually be situated between the fine lines about 60-70% of the time until the carcass is located (Chiszar et al., 1983; Golan et al., 1982, esp. Figure 1, Panel D; see also Brock, 1979; Dullemeijer, 1961; Gillingham & Baker, 1981). If it is assumed that normal specimens of *V. russelli* will perform at a level comparable to rattlesnakes, then it must be concluded that the present specimen exhibits deficient performance.

Nonetheless, our expectation was that the present specimen would be unable to follow trails. Its ability to do so must mean either that nasal chemoreception and volatile molecules are somehow involved in trail following or that molecules were transported to the vomeronasal organs by some nonlingual mechanism (cf. Cowles & Phelan, 1958; Halpern & Kubie, 1980). We cannot now decide between these alternatives. Furthermore, we cannot guess whether this snake's trailing ability is based on chemosensory mechanisms normally utilized by other conspecifics or if the present animal has acquired an unusual compensatory device because of its alingual status. Many studies dealing with the physiology and genetics of ophidian predatory behavior suggest that the latter idea may be correct (Arnold, 1981; Burghardt & Pruitt, 1975; Halpern & Frumin, 1979; Kubie & Halpern, 1979; Sheffield et al., 1968; Wilde, 1938). In any case, although the ophidian tongue is clearly involved in trail following by normal snakes (Burghardt, 1970; Chiszar, et al., 1983; Golan et al, 1982; Kubie & Halpern, 1979), it is important to recognize that other mechanisms may subserve this behavior. Hence, experiments which concentrate upon measures of lingual air sampling (see Chiszar & Scudder, 1980; and Chiszar et al., 1983 for reviews) cannot reflect alternative types of chemical-cue transport which contribute to trailing behavior.

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INTACT EXUVIAE IN LIZARDS

Most lizards molt piecemeal, as it were, often eating the shed parts as they are pulled off the body by the jaws. So generally is that rule valid that many herpetologists, including ourselves, are astonished to witness intact exuviae of any lizard. Entire cast skins are universally normal for snakes, as is commonly known in part because the dried remnants persist for weeks or even months under favorable conditions, and are thus encountered with some frequency.

Yet some lizards, notably gerrhonotine anguids, do cast entire exuviae, impressive with everted sections from the limbs as well as the head, trunk and tail. It is easy to see how a limbless animal could crawl out of an everted cast, but the limbs would seem to impose insuperable problems. Yet the animals do accomplish the impossible, as evidenced by the exuvia illustrated herewith (Fig. 1)

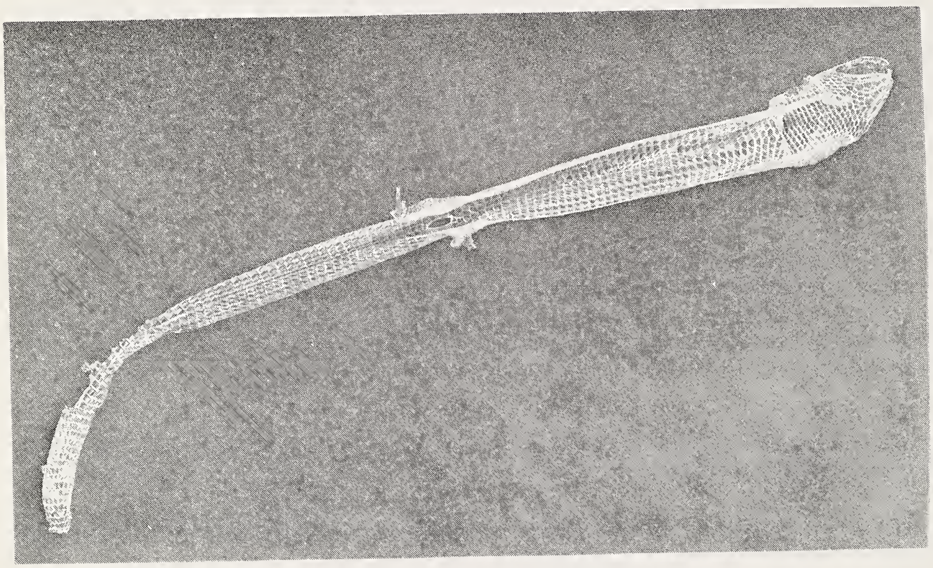

Figure 1. Exuvia of *Elgaria kingi nobilis*. See text for details.

It is from a 75 mm s-v *Elgaria kingi nobilis* taken by the senior author 3 mi SE of Elgin, Santa Cruz Co., Arizona, about 2 mi NW of the Huachuca Mts., 12 Aug. 1982, at about 4900 ft above sea level, in upland grassland. The specimen has been kept since then in a small cage heated by an incandescent bulb on a 10 hr L - 14 hr D regimen. On about 10 Oct. 1982, it cast the exuvia figured here. Especially notable are the sections, firmly attached to the rest, pulled from the limbs. The "sleeves" from the hind legs are readily evident protruding from either side of the anal aperture, but the foreleg sleeves are partially camouflaged, in this view, by the underlying gular section, since they dried in a forward-extended position; they can be deciphered however as a longitudinal white streak on either side in the throat region. They are complete down to the claws, although much of the terminal parts of the digits were sloughed without eversion.

The phenomenon of intact ecdysis in lizards has been known for many years, despite the widespread lack of familiarity with it. Oliver (1955:285) noted its occurrence in *Gerrhonotus* (sensu lato) and Bellairs (1960:289) in *Anguis* (reported as early as 1903 by Leighton). Vitt (pers. comm.) has observed it in *Elgaria coerulea*, *E. multicarinata*, *E. kingi*, *Gerrhonotus liocephalus*, and *Diploglossus lessonae* (although in the latter the exuvia is so delicate as to fall apart readily). Alvarez del Toro (1982:127) illustrated (fig. 84) the exuvia of a *Gerrhonotus liocephalus* from Chiapas, Mexico, and has observed similar intact exuviae in the Chiapas species of *Abronia* and *Barisia* (pers. comm.).

Accordingly, it appears that intact ecdysis occurs rather generally among the Anguidae, in all three subfamilies, although variation has been noted in the literature, patch-ecdysis sometimes occurring in animals that usually, or at least often, shed intact exuviae. Humidity variation undoubtedly has an effect on the form of the slough, as does health of the individual. So far as we are aware, in no other family is the exuvia shed intact, although the Anniellidae, being elongate-bodied and closely related to the Anguidae, is particularly suspect. Although elongate-bodied, the Dibamidae (including *Anelytropsis*) is not likely to exhibit intact ecdysis because it does not occur, so far as we are aware, in the closely related family Scincidae, known members of which molt in patches. The Pygopodidae presumably resemble the Gekkonidae, patch-molters, in this as well as in more fundamental respects.

Thus a taxonomic correlation appears to exist in mode of ecdysis, but its full significance cannot be appreciated until more is known about the variation of the character in more families and subfamilies.

We are much indebted for the benefit of the personal observations of Drs. Miguel Alvarez del Toro, Roger Conant and Laurie J. Vitt.

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NEWS AND NOTES:

AN OPEN LETTER TO THE MARYLAND HERPETOLOGICAL SOCIETY

The Maryland Natural Heritage Program was established in 1979 as a cooperative effort of the Maryland Department of Natural Resources and The Nature Conservancy, a private nonprofit organization dedicated to the preservation of natural diversity. In late 1981, the program joined the Land Planning Services section of the Department.

The Program is an ongoing, continuously updated inventory of natural features of significance in the State of Maryland, including populations of rare plants and animals and high-quality examples of terrestrial and aquatic community types. All such sites are being mapped onto a set of topographic maps, and selected locational and descriptive information for each occurrence is being indexed in a computer-based information system. Data is kept confidential if warranted or specified. The Heritage data base has become a major planning tool for the State of Maryland, used both for identifying and protecting significant natural areas, and for reducing impacts of public and private development activities.

As staff zoologist with the Maryland Natural Heritage Program, I am involved in the gathering and analysis of information on localities where rare, peripheral and disjunct animals occur. My works depends heavily on information provided by the many zoologists, naturalists, and others who have first-hand knowledge of the animals of Maryland. I am able to conduct a moderate amount of field work, but the major thrust of my work must be on specimen collections, literature (such as journal articles) and other information on current and historical occurrences of species of interest.

In Maryland, we are fortunate to have a certain amount of information available on herptiles via the MHS's "Endangered Amphibians and Reptiles of Maryland" (Bull. MD Herp. Soc., 9(3):42-100), Herb Harris' "Distributional Survey (Amphibia/Reptilia): Maryland and the District of Columbia" (Bull. MD. Herp. Soc., 11(3):73-167) and various reports by the Maryland Wildlife Administration's Non-Game and Endangered Species Office. However, much information on Maryland's rare herptiles is still lacking. For this reason, I am asking professional and amateur herpetologists who work in Maryland to get in touch with me if they have information on the locations of the following species:

Amphibians

Cryptobranchus a. alleganiensis
Ambystoma tigrinum tigrinum
Pseudacris brachyphona
Rana virgatipes
Aneides aeneus
Hyla gratiosa
Necturus maculosus maculosus
Plethodon wehrlei
Siren lacertina
Ambystoma jeffersonianum
Gastrophryne carolinensis
Gyrinophilus p. porphyriticus

The Institute for Herpetological Research is soliciting data for the revised and expanded edition of the Python Breeding Manual. The new edition will include breeding and husbandry data on all genera of boas and pythons. It will include plans for advanced egg incubator design based on our research and previous survey, as well as special aspects of boid husbandry. We are interested in observations made on special or unique requirements of boas or pythons that may contribute to ro augment captive breeding or general maintenance.

It is anticipated that the new edition will be completed in about one year. Contributors whose material is included in the Manual will receive credit for their contributions if requested. Forms for this survey can be obtained by writing to:

The Institute for Herpetological Research
P. O. Box 2227
Stanford, California 94305

When writing to request survey forms, please indicate the number of forms desired: one form is used for each breeding event. An explanatory letter describing the survey will be included with forms.

Richard Ross, M.D.
Director

Page no. 2

Reptiles

Virginia valeriae pulchra
Trionyx spiniferus spiniferus
Clemmys muhlenbergi
Eumeces anthracinus anthracinus
Farancia e. erytogramma
Pituophis m. melanoleucus
Cemophora coccinea copei
Eumeces inexpectatus
Graptemys geographica
Lampropeltis calligaster rhom.
Nerodia e. erythrogaster

Relay pertinent information to me at (301)269-3656 or (703)532-6267 in the evenings or write Maryland Natural Heritage Program, Tawes State Office Building, C-3, Annapolis, Maryland 21401. Please include species name, specific directions to the site and the date observed. Also, information such as numbers, age, sex, reproductive condition and habitat description would be most welcome. Your cooperation is very much appreciated.

Mary C. Brosnan
Staff Zoologist

NEWS AND NOTES:

ZCI PUBLICATIONS

1. 1st Annual Reptile Symposium on Captive Propagation & Husbandry. Seventeen papers dealing with captive propagation and husbandry, presented July 24, 1976 at Hood College, Frederick, Maryland. Papers include (Captive Maintenance of Lizards, E.G. Hofmann; Review of Husbandry and Propagation Procedures for Captive Crocodilians, M. Davenport ; Tortoise Husbandry, D. Goergen; Maintenance of Snakes in Captivity with Special Reference to the Genera Crotalus and Sistrurus, H.S. Harris, Jr.; Reptile Caging Methods at the Knoxville Zoological Park, J.R. Arnett; Practical Methods of Inducing Mating in Snakes using Extended Daylengths and Darkness, J. Laszlo; Notes on Photobiology, Hibernation, and Reproduction of Snakes, J. Laszlo; Research Results of Development of a Prepared Reptile Diet, R.S. Patton and R. Goellner; Hatching Techniques for Reptile Eggs at the St. Louis Zoo, R. Goellner; Procedures for Breeding Snakes at the Baltimore Zoo, F. Groves; Comments on a Technique for Hatching Eggs, J.V. Peavy, Jr.; Propagating Python Molurus sp., D. Goergen; Propagation of the Spotted Desert Gecko Eublepharis macularius in Captivity,E.G. Hofmann; Captive Propagation of Drymarchon corais, P. and G. Kuntz; Captive Propagation and Maintenance of Spilotes pullatus, P. and G. Kuntz; Some Parameters for Breeding Reptiles in Captivity, E. Wagner; Incubation of Snake Eggs, B. Bechtel.) 55 pages............................$12.50

2. 2nd Annual Reptile Symposium on Captive Propagation & Husbandry, presented June 23, 1977 at Case Western Reserve University, Cleveland, Ohio. Papers include: (An Unpopular Opinion, C. Peeling; Chelonian Husbandry, A. Wisnieski; Captive Maintenance of Crocodilians, J.D. Cook; Lizard Husbandry Techniques, R.P. Sinners; Caging and Feeding Techniques Employed at the Reptile Breeding Foundation, T.A. Huff; Probing as a Practical Method of Sex Recognition of Reptiles, Primarily Snakes, J. Laszlo; The Maintenance and Operation of the Reptile Collection at the New York Zoological Park, P Brazaitis; The Captive Propagation of Blue-tongued Skinks, Fact or Fantasy?, P.W. Evarts;A Reproductive Comparison of two Geochelone radiata (Shaw) with Notes on Incubation Technique, W. Zovickian; A Captive Breeding of the Green Tree Python, P. Gray; Captive Breeding of Colombian Raibow Boas, J.C. Brunner; Current Antibiotic Therapy in Reptiles, R. Ross; The Importance of being Earnest, Richard A. Hahn; Breeding the African Fat-tail Gecko, R.P. Sinners; Prepared Herp Diets, J.R. Arnett; Venomoid Snakes: A Discussion, J.L. Glenn, R.C. Straight; Reptile Reproduction at the Fort Worth Zoo: A Working Plan, J.P. Jones; Successful Breeding of the West African Dwarf Crocodile, C. Beck; The Management of Captive Chameleons, J.D. Groves; The Care of Breeding of Captive Yellow-tailed Cribos, T.L. Whitecar; Captive Propagation and Reproduction of the Leopard Tortoise, M. Flint; Some Aspects of Captive Propagation of Amphibians and Reptiles with the Aim of Conversation, R.E. Honegger.) 121 pages..$18.00

3. 3rd Annual Reptile Symposium on Captive Propagation & Husbandry. Seventeen papers dealing with captive propagation and husbandry presented August 10, 1979 at Knoxville Zoological Park, Knoxville, Tennessee. Papers include Records no longer a Luxury, Dale Marcellini; The Reptile and Amphibian Collection at the Columbus Zoo, Mike Goode; Probing for a Bargain, Kathleen Love; Notes on Thermal Requirements of Reptiles and Amphibians in Captivity, J. Laszlo; Reptile Reproduction and Husbandry of the Orange Striped Poison Dart Frog, Phyllobates vittatus at the Sedgwick County Zoo, D. Grow; Captive Breeding of the Australian Snakeneck Turtle Chelodina longicollis, E. Nicol; Conservation and Utilization of the Nile Crocodile Crocodylus niloticus, in Zimbabwe, B. Shwedick; Notes on an Unsuccessful Eyelash Viper Breeding Project, W. and K. Love; Breeding the Haitian Giant Galliwasp Diploglossus warreni, (Sauria: Anguinidae) at the

Knoxville Zoological Park, H. Lawler, C. Norris; Reproduction and Captive Maintenance of Koch's Day Gecko, Phelsuma madagascariensis kochi, E. Rundquist; Some Parameters for Breeding Boids in Captivity, T.A. Huff; Captive Breeding and Rearing of Young of the Solomon Island Ground Boa, Candoia carinata paulsoni, J. Fauci; Husbandry and Reproduction of the Red Tail Boa, Boa constrictor sep., S. Chiras; Territoriality in Python reticulatus, T. Crutchfield; Further Notes on the Husbandry, Breeding and Behavior of Chondropython viridis, T. Walsh; Incubating Python Eggs, A Synopsis of the Film, R. Ross; Breeding of Fiji's Banded Iguana in Captivity, Orchid Island Fijian Cultural Centre, I. Watkins;) 117 pages $18.00

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5. 5th Annual Reptile Symposium on Captive Propagation & Husbandry; 22 papers dealing with captive propagation and husbandry presented at the Oklahoma City Zoo, Oklahoma City, Oklahoma, June 11, 1980. Papers include; Is Captive Breeding a Useful Conservation Tool?, P. Pritchard; The Failing of Sherlock Holmes (The Danger of Interbreeding Subspecies); A Review of Hybridization in Reptiles, Past and Present, E. Wagner; Intrabrood Variation in Boas and Pythons, R. Funk; Management of Gram Negative Disease in Captive Reptiles, R. Ross; U.S. Fish and Wildlife Service Regulations and Permits, D. Vogler; Courtship and Nesting Behavior in Cyclura rubila lewisi, T. Crutchfield; Maintenance of Pit Vipers in Captivity, J. Murphy; The Role of Thermoclines and Temperature Variance in Reptile Husbandry, K. Neitman; Reproduction in Captive Agkistrodon bilineatus taylori at the Houston Zoo, K. Peterson; Captive Propagation and Husbandry of Crotalus catalinensis at the Fresno Zoo, R. Tremper; Reproduction in Captive Kenya Sand Boas, Eryx colubrinus loveridgei (Stull), J. McLain; Reptile Breeding Techniques Used at the San Antonio Zoo, Emphasis on Temperature and Photo Period Manipulation, A. Kordon; Maintenance and Reproduction of Pythons at the Dallas Zoo, D. Barker; Priorities and Techniques of Captive Breeding Reptiles at the Honolulu Zoo, With an Emphasis on

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NEWS AND NOTES:

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Kenneth R. G. Welch was educated at Bristol Grammar School, England, and has worked on the snake farms (Orm-Expo) at Furuviksparken and Tradgardsforeningen, Goteborg in Sweden. He has collected and studied reptiles in the field in Europe, North Africa, Australia and the West Indies and has written various papers and co-authored the checklist of the venomous snakes of the world.

Mr. Welch is a Fellow of the Linnean Society and the Royal Geographical Society. He is a Life Member of the British Herpetological Society; and a member of the Society for the Study of Amphibians and Reptiles (U.S.A.) and the International Society of Toxinology.

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ISBN: 0.12.274613.9
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NOTES:

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Maryland Herpetological Society

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JUNE 1983

VOLUME 19 NUMBER 2

BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

Volume 19 Number 2 June 1983

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The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
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BULLETIN OF THE mdhs

Volume 19 Number 2 June 1983

The Maryland Herpetological Society

Department of Herpetology, Natural History Society of Maryland, Inc.

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Bulletin of the Maryland Herpetological Society

Volume 19 30 June 1983 Number 2

New Herpetological Records from the State of México

J. Luis Camarillo Rangel

The herpetological literature compiled by Smith and Smith (1976a and 1976b) reveals that few recent works deal with the herpetofauna of the State of México, and that our knowledge of this part of the country is still fragmentary.

Eighty-seven species may be considered as reliably reported from the state, if records of *Ambystoma dumerili, Bufo americanus, Syrrhophus longipes, Phrynosoma douglassi, Sceloporus formosus, Sceloporus poinsetti, Elaphe bairdi, Lampropeltis mexicana, Rhadinaea fulvivittis, Salvadora grahami, Natrix erythrogaster, Crotalus pricei, Crotalus basiliscus, Kinosternon herrerai* and *Sternotherus odoratus* are deleted, for these taxa occur in areas far away from the State of México and thus were probably misidentifications. Other taxa, such as *Eumeces lynxe, Storeria occipitomaculata, Crotalus durissus* and *Crotalus scutulatus* were apparently presumptive records which require verification with specimens.

Seventy of the valid records are of species which inhabit the Central and Northern portions of the state, where the climate ranges from temperate subhumid to cold subhumid, plus a small area to the Northeast with semidry climate, all with a summer rainy season.

To the Southwest, almost one-fifth of the area of the State of México (± 4300 of 21,461 km^2 according to García and Falcón, 1974) is under 2,000 meters in elevation and has an Aw (hot subhumid) climate, with summer rains. This area supports subtropical communities such as low or medium deciduous forests (INIF, 1964; Rzedowski, 1978). Dominant plants may include *Bursera* (some 10 spp.), *Pseudosmodingium perniciosum, Amphypterygium adstringens, Lysiloma microphylla, Ceiba parvifolia, Cyrtocarpa procera, Ipomoea murucoides*, etc., depending on the local topography and type of soil. Other conspicuous plants are *Thevetia ovata, Brahea dulcis* and *Ficus petiolaris*.

From this important area, which in addition is in direct connection with the Balsas River Basin, only 16 tropical species of amphibians and reptiles had been recorded.

Among the few recent works on the herpetozoa from the state are those by Ramírez, *et al.* (1980) reporting on a community of reptiles and amphibians in the Northwest of the Valley of México; Sanchez-Herrera and López-F. (1980) recording *Abronia deppei* from the subhumid forests South of Valle de Bravo; Aguilar, *et al.* (1981) who summarize the herpetofauna of the Sierra de Guadalupe, to the North of the state: and Camarillo (1981) who studied the elevational distribution of herptiles on the Balsas-facing slopes of the mountains of Ocuilan and Chalma.

All of the above-mentioned information led me to speculate about the possible existence of a much higher diversity of amphibians and reptiles in the Southwest of the state than that previously known. Thus, I started a formal survey of the area of which this constitutes the first report.

Field work was conducted in seven localities (listed in Table 1) from December 1978 to February 1983, and the materials are deposited either in the Colección Herpetológica of the Instituto de Biología (IBH) or the Vivario y Colecciones, Escuela Nacional de Estudios Professionales Iztacala (ENEPI), both of the Universidad Nacional Autónoma de México.

TABLE 1

Localities of the State of México included in the present paper

Name	Coodinates	Elevation (meters)
Bejucos	18°45'N,100°27'W	578
Chalma	18°46'N, 99°25'W	1,750
El Durazno	19°11'N,100°11'W	1,680
Grutas de la Estrella	18°43'N, 99°40'W	1,700
Tingambato	19°05'N,100°25'W	700
Zacazonapan	19°03'N,100°16'W	1,230

Results

The species which represent new state records are, to date:

AMPHIBIA

Bufonidae

Bufo marinus horribilis Wiegmann

Three specimens:

Tingambato - IBH3549, 14 May 1981; ENEP1497, 5 February 1983.

Bejucos - ENEP1167, 4 July 1981.

Bufo perplexus Taylor

Two specimens:

Tingambato - ENEP1168 and ENEP1282, 22 June 1981.

Hylidae

Hyla smithi Boulenger

Two speciments:

Chalma - IBH3259, 28 January 1979; IBH3260, 3 December 1978.

Pachymedusa dacnicolor (Cope)

Five specimens:

Bejucos - ENEP1165, 166, 349, 464, 465, 4 July 1981.

Pternohyla fodiens Boulenger

One specimen:

Bejucos - ENEP1153, 6 July 1981.

Smilisca baudini (Duméril and Bibron)

One specimen:

Bejucos - ENEP1155, 4 July 1981.

Ranidae

Rana pustulosa Boulenger

Two specimens:

El Durazno - ENEP1304, 13 June 1981.

Grutas de La Estrella - ENEP1305, 20 June 1981.

REPTILIA

Emyidae

Rhinoclemmys rubida perixantha (Mosimann and Rabb)

One specimen:

Bejucos - ENEP1485, 25 June 1981.

Gekkonidae

Phyllodactylus lanei rupinus Dixon

Two specimens:

Tingambato - IBH3550 and 3551, 14 May 1981.

Iguanidae

Anolis nebulosus (Wiegmann)

Four specimens:

Chalma - IBH3256 and 3548, 1 April 1979.
IBH3257, 6 May 1979.
IBH3258, 26 February 1979.

Ctenosaura pectinata (Wiegmann)

One specimen:

Bejucos - ENEPI522, 26 February 1983.

Sceloporus horridus horridus Weigmann

Five specimens:

Chalma - IBH3269 and 3270, 3 December 1978.
IBH3271 and 3272, 7 January 1979.
IBH3273, 28 January 1979.

Sceloporus horridus oligoporus Cope

Two specimens:

El Durazno - ENEPI157, 14 May 1981.
Bejucos - ENEPI419, 28 September 1982.

Sceloporus melanorhinus calligaster Smith

One specimen:

Bejucos - ENEPI159, 4 July 1981.

Urosaurus bicarinatus bicarinatus (Duméril)

Six specimens:

Chalma - IBH3225, 1 April 1979.
IBH3226, 26 January 1979.
IBH3227, 24 March 1979.
IBH3228, 28 January 1979.
IBH3229, 26 February 1979.
Bejucos - ENEPI163, 22 June 1981.

Teiidae

Cnemidophorus deppei infernalis Duellman and Wellman

One specimen:

Tingambato - ENEP1163, 22 June 1981.

Colubridae

Drymarchon corais rubidis Smith

One specimen:

Bejucos - ENEP1176, 24 June 1982.

Leptodeira splendida bressoni Taylor

One specimen:

Bejucos - ENEP1162, 4 July 1981.

Leptophis diplotropis diplotropis (Günther)

Two specimens:

Chalma - IBH3264, 7 January 1980.
IBH3265, 17 October 1978.

Salvadora mexicana (Duméril, Bibron and Duméril)

One specimen:

Zacazonapan - ENEP1364, 22 June 1981.

Tantilla deppei (Bocourt)

One specimen:

Chalma - IBH3242, 6 May 1979.

Trimorphodon biscutatus biscutatus (Dumeril, Bibron and Duméril)

One specimen:

Tingambato - ENEP1496, 4 February 1983.

Crotalidae

Crotalus durissus culminatus Klauber

One specimen:

Chalma - ENEP1342, 20 September 1981.

Another record which is worth mentioning is that of a *Pituophis lineaticollis lineaticollis* (Cope) from Chalma, ENEP1340, 5 June 1981, for this snake had been recorded from the State of México only once (by Duellman, 1960) from a locality 40 km North of Mexico City.

Discussion

The taxa herein reported raise the total number of species known from the State of México to 111. The proportion of species of tropical affinity is now considerably higher (35.13%) than formerly thought (17.24%) and we expect it to grow still more as new collections are secured.

Other miscellaneous aspects of this work merit attention, such as the most remarkable records of *Pternohyla fodiens*, *Rhinoclemmys rubida perixantha* and *Sceloporus melanorhinus calligaster*, whose range actually extends deeply into the Balsas Basin.

Rhinoclemmys rubida had been recorded from Apatzingan, Michoacan (Schmidt and Shannon, 1947); later, Mosimann and Rabb (1953) referred that record to their new subspecies *perixantha* though as a localized variation into the Balsas Basin approaching *R. rubida rubida* in certain characters. Our specimen is easily referred to *perixantha* as can be seen in Table 2 and thus confirm Mosimann and Rabb's opinion, about the presence of *perixantha* in the Basin.

TABLE 2

Comparison of Meristic Characters of *Rhinoclemmys rubida* From Two Areas in the Balsas Basin, With Values Diagnostic for Subspecies

Variate	*rubida*	*perixantha*	APARZINGAN+	BEJUCOS
Marginal Flare	13.29±0.83	18.66±2.70	14 - 14	18.9
Humeral/Gular Ratio	0.49±0.05	0.70±0.13	0.73-0.44	0.67

+Data for Apatzingan are of the two specimens reported by Schmidt and Shannon (1947).

Means and SDs for the two subspecies from Mosimann and Rabb (1953).

The record of *Pituophis l. lineaticollis* by Duellman (1960) is from the area of Jiquipilco and Villa del Carbón. The vegetation there includes pine and pine-oak forests as well as some patches of scrub (Rzedowski, *et al.*, 1964); this is in contrast with the mixed subtropical forests where we collected this snake. Furthermore, recent surveys of the northern area (Ramírez, *et al.*, 1980, and Aguilar, *et al.*, 1981) have shown that *Pituophis d. deppei* is the only species of genus to be expected there.

It is possible that the locality cited by Duellman (1960) had originated through incorrect data on the label or some other unfortunate event. We regard that record as very doubtful until more information is available.

Microsympatry of *Crotalus durissus culminatus* and *Pituophis l. lineaticollis* is documented by our specimens for a range from 1750 to 1900 meters of elevation in Chalma. This supports the hypothesis advanced in this sense by Sánchez-Herrera, *et al.*, (1981) in relation to a mimicry system involving both snakes.

Acknowledgements

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A NEW FROG OF THE GENUS *COLOSTETHUS* FROM THE ISLAND OF TOBAGO, WEST INDIES (ANURA: DENDROBATIDAE)

Jerry D. Hardy, Jr.

Mertens (1970) first recorded frogs of the genus *Colostethus* from the Island of Tobago, calling them *Phyllobates trinitatis*. Although *Colostethus trinitatis* (formerly *Phyllobates*) has historically been recorded from both Trinidad (Garman, 1887) and Venezuela (Rivero, 1961), Edwards (1974) has presented evidence to suggest that this species does not, in fact, occur in Venezuela.

The *Colostethus* of Tobago is also not con-specific with *Colostethus trinitatis* of Trinidad, and is apparently un-described. In recognition of her work with frogs in the Southeastern Caribbean and on Tobago, the new frog is named for Janet Olmon, formerly of The Virginia Institute of Marine Science.

Colostethus olmonae sp. nov.

Phyllobates trinitatis. — Mertens, 1970 (first Tobago record).

Phyllobates trinitatis trinitatis Garman. — Mertens, 1971 (listed from Tobago).

Colostethus [sp.]. — Hardy, 1977 (biogeography).

Colostethus trinitatis. — Krintler, 1982a, 1982b (occurrence, life history, behavior).

Colostethus cf *dunni* (Rivero). — Hardy, 1982, 1983 (biogeography, voice).

Holotype: USNM 198505, collected on August 31, 1972, at Bloody Bay, St. John Parish, Tobago, West Indies.

Paratypes: (See "Specimens Examined").

Range: Known only from mountainous areas on the Island of Tobago, West Indies.

Diagnosis: A relatively small dendrobatid frog characterized by the presence of yellow ventral pigment, a distinct dark chest-bar, moderately well-developed webbing between all of the toes, dermal fringes on the fingers and toes, and a call consisting of a long series of evenly-spaced single notes. Females reach a maximum snout-vent length of 24.9mm, males 21.6mm.

Description of the holotype: A female having a snout-vent length of 21.6mm. Snout blunt, only slightly rounded in dorsal profile, sloping in lateral view; canthus moderately distinct, rounded, slightly concave; loreal region essentially straight; nostrils much closer to tip of snout than to eye; diameter of eye greater than distance of eye to nostril, extending almost to tip of snout; tympanum length contained approximately twice in diameter of eye. Sides, back, and upper surfaces of legs tuberculate; belly pustulate; chin smooth. Tympanum distinct, partially concealed above; supratympanic fold poorly developed. Tongue oval, very slightly notched behind; cloanae moderate, their outer edges barely hidden under the maxillae. A clearly defined mid-dorsal ridge from between eyes to posterior part of body.

In life, ground color of dorsum light brown; a dark interorbital triangle and canthal streak; a distinct greenish-brown "x" on back connected by two thin oblique dark lines to the interorbital triangle; a dark inverted "V" mark on posterior part of dorsum; dorsolateral stripe very light brown, bordered below by grayish extensions of the face mask; oblique lateral stripe yellow and crossed with irregular bands of grey; upper surfaces of legs light brown; mid-point of femur and tibia each crossed with a narrow dark band; femur with a second broader but less distinct band proximally; a well-developed dark crossband in the pectoral region; chin and lateral aspects of belly lemon yellow; two prominent darker yellow patches just back of pectoral band; yellow ventral pigment sharply delineated from flesh color of ventral aspects of arms; eye bronzy and with black reticulations and a black horizontal band.

In alcohol, pectoral bar reduced; yellow ventral pigment entirely faded, underparts uniform white except for pectoral bar; dorso-lateral stripe paler, more clearly defined than in life; oblique lateral stripe with scattered patches of brownish pigment, upper and lower jaws strippled with brown.

Variations in the paratypes: Most living *Colostethus olmonae* are brown dorsally, although some individuals are grey or greyish-green. In freshly collected specimens the yellow ventral pigment is restricted to the chin and pectoral region. In captive individuals the yellow pigment tends to spread over the entire abdomen.

In most individuals the dorsal pattern is obscure or essentially lacking (in contrast to the distinct pattern of the holotype). The oblique lateral stripe is highly variable and is sometimes evident only as a series of white spots or dashes.

In males the ventral surfaces of the chin, abdomen, arms, and legs are finely stippled with black. In medium-sized females the abdominal region is immaculate, while in larger females there are usually scattered chromatophores on the anterior half of the abdomen and the ventral surfaces of the legs. Abdominal stippling also occurs in very young specimens, sometimes forming two greyish lines which extend from the pectoral region obliquely outward across the anterior half of the abdomen.

The loreal region and the edge of the upper jaw are usually whitish and marked with stippling or mottling of darker; in some specimens, however, this area is predominately dark.

The hind legs usually have well-defined cross bands, but in some individuals these may be completely obliterated by darker pigment. A longitudinal stripe usually occurs on the upper arm, but this too may be absent.

Comparisons: On purely geographic grounds, it is necessary to compare *Colostethus olmonae* (Figure 1) to *Colostethus trinitatis* of Trinidad (Figure 2); otherwise *C. olmonae* is most similar to *C. dunni* (Figure 3), a species found between the vicinity of Caracas and Maracay in the Coastal Range of Venezuela. Two characters, voice and toe webbing, distinguish these three species. In addition, *C. olmonae* can be distinguished from *C. trinitatis* on the basis of differences in the outline of the face mask and the number of back-riding tadpoles.

Figure 1. *Colostethus olmonae*. The holotype photographed alive. A. Dorsal view. B. Ventral view. C. Lateral view.

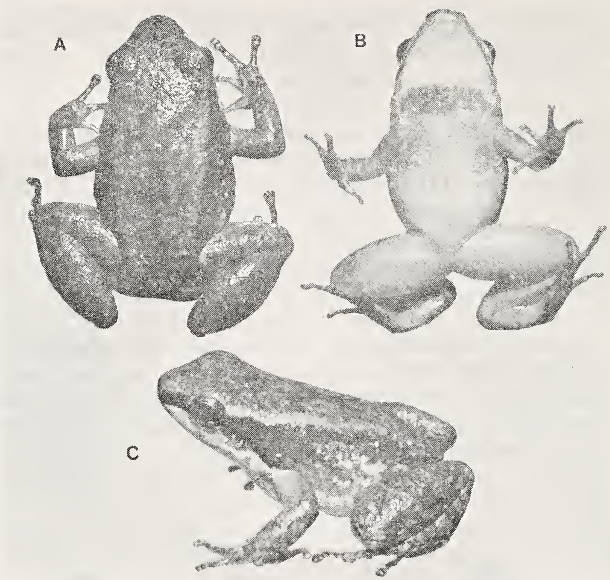


Figure 2. *Colostethus trinitatis*. Typical specimen, photographed alive. A. Dorsal view. B. Ventral view. C. Lateral view.

Figure 3. *Colostethus dunni*. Preserved specimen. A. Dorsal view. B. Ventral view.

Voice: *Colostethus trinitatis* produces a series of two-note calls (Figure 4a). Although Wells (1980) gave a frequency range of 4.3 to 4.6 KHz, values obtained during the present investigation were somewhat broader. The first note of the call begins at 3.1 to 4.2 KHz (average 3.9 KHz) and ends at 3.9 to 4.6 KHz (average 4.3 KHz), while the same values for the second note vary from 3.8 to 4.3 KHz (average 4.0 KHz) to 4.1 to 4.7 KHz (average 4.4 KHz). The first few notes of a call sequence are typically at a lower frequency than subsequent notes. As pointed out by Wells (1980) *Colostethus trinitatis* also produces a trilled call consisting of a rapid series of evenly spaced notes (Figure 5a). An individual call sequence may contain from 17 to 115 two-note calls (average 52) and last from 5.6 to 44.9 seconds (average 13.6). The interval between call sequences is usually rather long.

In contrast to the distinctive two-note call of *Colostethus trinitatis*, the calls of both *Colostethus olmonae* and *C. dunni* consist of a long series of single notes.

Colostethus olmonae produces an average of 2.4 calls per second (Figure 4b). The individual notes begin at 3.2 to 4.0 KHz (average 3.7) and end at 3.7 to 4.7 KHz (average 4.3). Individual call sequences may contain 36 to 347 individual notes (average 144) and last from 15.3 to 128.3 seconds (average 59.5). As in *C. trinitatis*, the first few notes of a call sequence may be significantly lower than the following notes. *Colostethus olmonae* also produces a harsh call which differs in structure from the typical call (Figure 5b). The significance of this call is unknown.

The structure and frequency of the call of *Colostethus dunni* is quite similar to that of *Colostethus olmonae* (Figure 4c). Based on recordings provided by the University of Kansas, the individual notes begin at a minimum frequency of 4.4 KHz and end at a maximum of 5.1 KHz. *Colostethus dunni* calls at an average rate of 4.2 times per second, and individual call sequences may contain 6 to 195 notes with an average of 77.

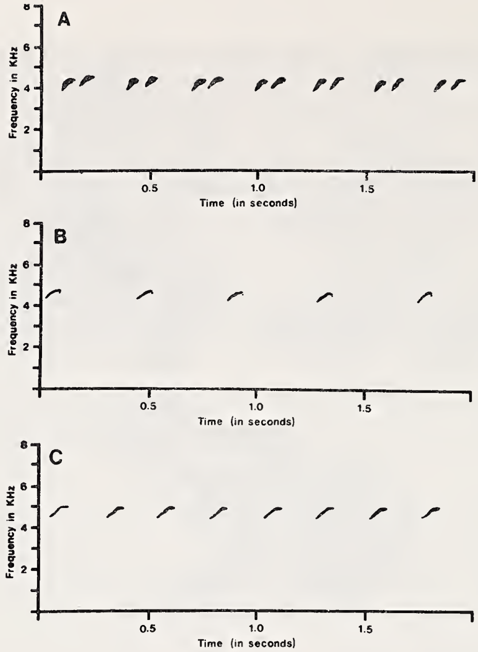


Figure 4. Typical calls of three species of *Colostethus*. A. *Colostethus trinitatis*. B. *Colostethus olmonae*. C. *Colostethus dunni*.

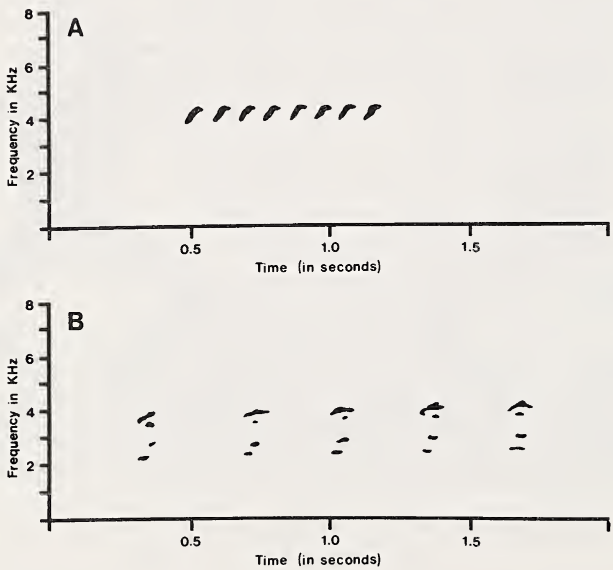


Figure 5. Variant calls of *Colostethus*. A. Trilled call of *Colostethus trinitatis*. B. Harsh call of *Colostethus olmonae*.

To briefly summarize, *Colostethus trinitatis* has a highly distinctive 2-note call. The single-note calls of *C. olmonae* and *C. dunni* are similar in frequency (3.2 to 4.7 KHz in *olmonae*, 4.3 to 5.1 KHz in *dunni*); but the call rate is distinctly different (2.4 calls/second in *olmonae*, 4.2 calls/second in *dunni*).

Toe webbing (Figure 6): Toe webbing immediately distinguishes *Colostethus olmonae* from *Colostethus trinitatis*. In *C. olmonae* there is moderately well-developed webbing between all of the toes, whereas in *C. trinitatis* webbing is completely lacking between the first and second toes and otherwise greatly reduced. In *Colostethus dunni* the toe webbing is consistently much more extensive than in *C. olmonae*. Toe webbing in *C. olmonae* may, in fact, be considerably reduced, but webbing is always present between the first and second toe.

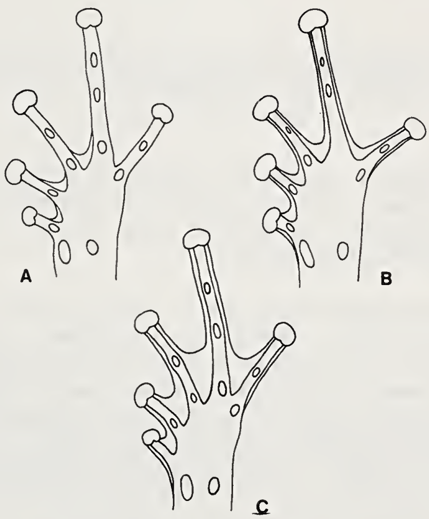
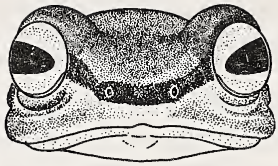
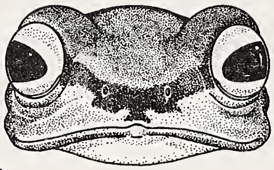


Figure 6. Variations in toe webbing. A. *Colostethus trinitatis*. B. *Colostethus olmonae*. C. *Colostethus dunni*. (Illustrations by Dana Sutton).

Face mask: In *Colostethus trinitatis* the lower edge of the face mask, in the area between the nostrils, is typically straight-edged, whereas in *C. olmonae* it is distinctly ragged and usually has a median pigment spot projected downward toward the upper lip (Figure 7). This character is highly variable in *Colostethus dunni*.



A



B

Figure 7. Variations in the face mask. A. *Colostethus trinitatis*. B. *Colostethus olmonae*.

Back-riding tadpoles: Males of *Colostethus trinitatis* carry between 7 and 12 tadpoles (average 7.5), whereas, in *C. olmonae* the same counts vary from 11 to 19 (average 14.3). No data are available on the number of back-riding tadpoles in *Colosthethus dunni*.

Discussion: *Colostethus olmonae* is clearly very similar to *Colostethus dunni* of Venezuela (Figure 8). There are, on Tobago, six other amphibians and reptiles which do not occur on Trinidad, but which are identical or strikingly similar to species occurring on the South American mainland. Four of these (*Eleutherodactylus terraebolivaris, Eleutherodactylus rozei, Flectonotus pygmaea,* and *Atractus univittatus*) occur in the same area in Venezuela as *Colostethus dunni*. The Tobago and Venezuelan populations of *Eleutherodactylus terraebolivaris* appear to be identical, while the taxonomic status of *Eleutherodactylus* cf *rozei, Flectonotus* cf *pygmaea*, and *Atractus* cf *univittatus* remain problematic. Two other Tobago species (*Bachia* cf *flavescens* and *Centrolenella* cf *orientalis*) present similar taxonomic problems, but are related to species in other parts of northern South America. The odd faunal similarity between Tobago and the Coastal Range of Venezuela west of Caracas is, indeed, most striking. Future research may show that *Eleutherodactylus* cf *rozei, Flectonotus* cf *pygmaea, Colostethus olmonae,* and *Atractus* cf *univittatus* are all sub-specifically related to their South American counterparts. Such an arrangement would clearly support the notion that the Tobago populations are, in fact, ancient stocks of once widely distributed South American species. A great deal of work remains to be done on the taxonomy of all of these oddly distributed Tobagonian and Venezuelan species and/or populations before the puzzling biogeographical paradox of Tobago is adequately understood.

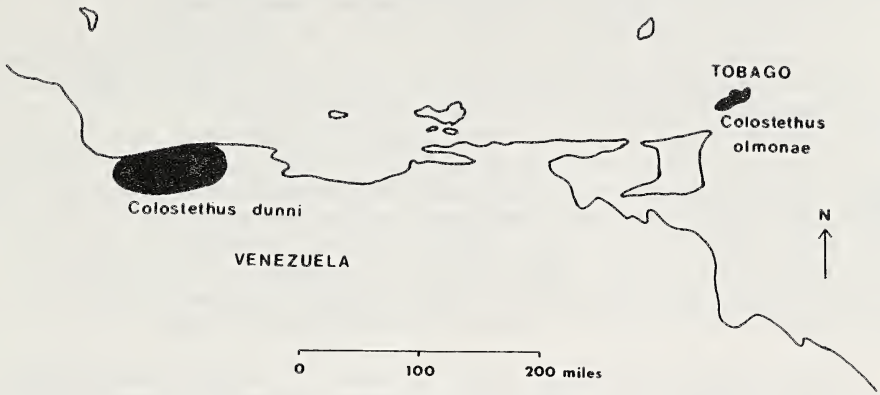


Figure 8. Map of northern South American showing the distribution of *Colostethus olmonae* and *Colostethus dunni*.

Specimens examined:

Colostethus dunni. KU 133018-48, Venezuela, District Federal, 5 km south El Limon, road to Colonia Tovar, 800 meters; 185716, Venezuela, Aragua, Maracay-Ocumare de laCosta Road.

Colostethus olmonae (Paratypes): AMNH 87259-68, St. John Parish, Tobago, hills above Man-of-War Bay, 1.5 to 3.5 km. ENE of Charlotteville, elevation 5 to 100 meters, 26 to 31 January, 1972. BM 1935.10.1.1, Tobago, Central Ridge, 29 August 1935. FMNH 191940-49, Tobago, St. John Parish, intersection of Bloody Bay Creek and the Bloody Bay-Charlotteville Road, 1 September 1972. MCZ 87009-18, Tobago, St. John Parish, intersection of Bloody Bay Creek and the Bloody Bay-Charlotteville Road, 1 September 1972. SMF 66694-701, Tobago, St. David Parish, Moriah, 22 November 1969. UK 154404-27, Tobago, St. John Parish, intersection of Bloody Bay Creek and Charlotteville-Bloody Bay Road. USNM 167506, Tobago, St. John Parish, Charlotteville-Bloody Bay Road, vicinity of mile marker 28 3/4, 5 July 1970; 195042, Tobago, St. John Parish, Charlotteville-Bloody Bay Road, vicinity of mile marker 28 3/4, 29 August 1972; 195043, Tobago, St. John Parish, Roxborough-Parlatuvier Road, vicinity of Bloody Bay, 31 August 1972;

195118-25, Tobago, St. John Parish, Charlotteville-Bloody Bay Road, vicinity of mile marker 28 3/4, 5 September 1972; 190506-08, Tobago, St. John Parish, near Hermitage at mile marker 29 3/4, 29 August 1972; 198509-13, St. John Parish, near Hermitage at mile marker 29 3/4, 30 August 1972; 227746-47, St. John Parish, on hill above Speyside, 6 July 1979; 227748-52, Tobago, St. Paul Parish, 2.2 miles north and 2.0 miles west of Roxborough, 16 July 1979; 227753-54, Tobago, St. John Parish, 2 miles WSW of Hermitage Bridge at mile marker 29 1/2, 16 December 1978; 227755, Tobago, St. John Parish, 1.5 miles SW Charlotteville at mile marker 30.9, 16 December 1978; 227756-68, Tobago, St. John Parish, 1 1/4 miles SW Charlotteville, 26 December 1978; 227769-74, Tobago, St. John Parish, about 2 km south of Charlotteville, on Pigeon Peak Trail, 7 July 1979; 227775, Tobago, St. John Parish, about 3 km SW Charlotteville, 11 July 1979; 227776-78, Tobago, St. John Parish, Charlotteville, 12 July 1979; 22779-83, Tobago, St. John Parish, 3 3/4 miles WSW of Charlotteville at mile marker 27 1/2, 30 March 1979.

Colostethus trinitatis. USNM 141546-67, Trinidad, August 1953 (variously recorded from La Veronica, Lapinot, Morne Blue, and Blue Basin); 146355, 146359-60, Trinidad, Arima Valley, Spring Hill Estate, 8 January 1962; 166302-04, Trinidad, Arima Valley, Spring Hill Estate, trail to Guacharo Cave, 8 November 1967; 166305-37, Trinidad, Maracas Valley, along trail to Maracas Waterfall, 11-12 November 1967; 166338-42, Trinidad, El Tucuche, 2500 feet, 15 November 1967; 195160, Trinidad, St. George Co., Arima Ward, Spring Hill Estate, 8 September 1972; 198514, Trinidad, St. George Co., Arima Valley, north of Morne Blue, just south of mile marker 19 1/4 on Blanchissuese-Arima Road, 28 August 1972; 198515, Trinidad, St. Andrew Co., Mt. Tamana, intersection of Tamana Road (section 2) and Matura Road, 28 August 1972; 230735-38, Trinidad, St. George Co., Maracas Valley, base of Maracas Waterfall, 2 August 1972.

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FROGS AND TOADS OF STORMWATER MANAGEMENT BASINS IN COLUMBIA. MARYLAND

In late Spring of 1982 evening call counts of frogs and toads were made at 14 selected stormwater management basins in Columbia, Maryland (Howard County). Five basins were retention ponds (i.e., ponds with permanent water pools) and nine were detention basins (i.e., basins designed to temporarily detain water after a heavy rain and to release it slowly to a receiving body of water). Five of the nine detention basins were located on streams. All basins and ponds were located in the Piedmont Plateau physiographic region, but much of the study area was within a few kilometers of the Coastal Plain. The study was part of a larger project investigating urban wetlands for stormwater control and wildlife enhancement (Adams, et al. 1983).

Between 27 May and 24 June eight separate counts were made following a selected automobile route between basins. Terminal position of the route was reversed on alternating evenings. Counts began at 8:30 PM and were usually terminated by 11:15 PM. At each basin on 27 May and 2 June, the observer left his vehicle and spent 10 minutes adjacent to the basin recording, by species, all frog and toad calls heard. After the first two survey periods, time spent at each basin was reduced to 5 minutes because no additional species were recorded in the second 5-minute period of the initial surveys. Data presented in this note represent the minimum number of species present in the study area. Species we recorded are generally considered abundant in the area (Harris, 1975), except for Fowler's toad (*Bufo woodhousei fowleri*).

Three species of frogs and two species of toads were recorded in the study. These amphibians were influenced by different types of stormwater control basins (Table 1). Detention basins lacking streams attracted only American toads (*Bufo a. americanus*). The species is widespread and abundant in the Northeast, and lives in a variety of habitats. However, toads do require shallow bodies of water in which to breed (these may be temporary pools or ditches), shelter in the form of hiding places where there is some moisture, and an abundant supply of insects and other invertebrates for food. Detention basins without streams in the study area were maintained by mowing and very little wildlife cover was present. However, some unmowed herbaceous vegetation was present near inlet and outlet structures, and portions of the basins were often too wet for mowing. American toads were attracted to these small pockets of habitat.

TABLE 1

Frequency of occurrence of frogs and toads recorded during evening call surveys of 14 stormwater management basins, Columbia, Maryland; Spring, 1982.[1]

Species	Retention pond	Detention basin with stream	Detention basin without stream
B. americanus	0.23	0.20	0.28
B. woodhousei fowleri	0	0.12	0
H. versicolor	0.23	0.45	0
R. catesbeiana	0.13	0	0
R. clamitans	0.62	0.40	0

[1]Data represent frequency of occurrence for a total of 39 visits to five retention ponds, 40 visits to five detention basins with streams, and 32 visits to four detention basins without streams.

The presence of a stream through a detention basin provided much better amphibian habitat. Such basins were much wetter than detention basins without streams and often contained shallow pools of water over much of the basin floor for extended periods of time. Because of the wet bottoms, these basins were not mowed and some wetland and upland vegetation was allowed to grow. The most abundant frog species recorded in this basin type was the Gray treefrog (*Hyla versicolor*). Choruses of treefrogs were often heard in the basins. These frogs remained chiefly in relatively small trees or shrubs that were near or actually standing in shallow bodies of water. This species is not often seen on the ground, except during the breeding season. Detention basins with streams also contained the Green frog (*Rana clamitans melanota*), the most abundant and widely distributed species in the study. The Green frog requires shallow, fresh water and inhabits springs, creeks, ditches and the edges of lakes and ponds.

Detention basins with streams provided the best toad habitat. In addition to the abundant American toad, Fowler's toad was recorded. Fowler's toad is an abundant species of the Atlantic Coastal Plain but was not widely distributed in our study area. The species was recorded at two of the five detention basins with streams during four survey periods. In each instance only one individual was heard calling.

Retention ponds were not as attractive to toads and treefrogs as were detention basins, but were more attractive to the true frogs (family Ranidae). The most common species recorded from this family was the Green frog, but the Bullfrog (*R. catesbeiana*) also was found in retention ponds. As a general rule these species require more water than the toads and treefrogs.

The Spring Peeper (*Hyla c. crucifer*), a treefrog, also was quite numerous in the study area, but generally breeds earlier than the other species and was not recorded in the call survey. However, this species was recorded earlier in the season during a systematic bird census. Peepers were most commonly heard at detention basins containing streams, as were the Gray treefrogs. Shallow ponds with gently sloped sides had numerous peepers, but deep ponds with steep slopes had very few.

Acknowledgment

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—John J. Bascietto and Lowell W. Adams, *National Institute for Urban Wildlife, 10921 Trotting Ridge Way, Columbia, Maryland 21044.*

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NEWS AND NOTES:

THOSE FASCINATING POISON FROGS

All amphibians bear poison glands, along with mucus glands, in their skin, but in no anurans are the poison glands better developed than in the frogs of the family Dendrobatidae. The "poison frogs", as members of the family are known, have numerous other, equally fascinating traits, briefly reviewed here from the works noted in the literature cited.

In 1823-24, while Captain Charles Stuart Cochrane was on leave from the British navy, he went exploring in Colombia on foot. In his book, TRAVELS IN COLOMBIA, he noted the interesting manner in which Choco Indians make use of frogs "called 'rana de veneno' (by the Spanish), about three inches long, yellow on the back, with very large, black eyes." He observed that "those who use (their) poison catch the frogs in the woods and confine them in a hollow cane, where they regularly feed them until they want the poison, when they take one of the unfortunate reptiles and pass a pointed piece of wood down his throat and out at one of his legs. This torture makes the poor frog perspire very much, especially on the back, which becomes covered with white froth: This is the most powerful poison that he yields, and in this, they dip or roll the points of their arrows, which will preserve their destructive power for a year. Afterwards, below this white substance, appears a yellow oil, which is carefully scraped off, and retains its deadly influence for four to six months. According to the goodness (as they say) of the frog. By this means, from one frog sufficient poison is obtained for about fifty arrows."

Later observers independently verified Cochrane's observations. Among these was S. Henry Wassen, a Swedish anthropologist. Wassen found that three groups of Choco Indians on the western slope of the Andes in Colombia used frogs to poison their darts: two related groups along the San Juan River and one isolated group far to the south along the Saiga River.

The northern Choco Indians, who live in an area extending from the San Juan river basin northward towards Panama, use two species of frogs, *Phyllobates aurotaenia* and *P. bicolor*. These people give the frog very much the same treatment as that described by Captain Cochrane. However, C. W. Myers and J. W. Daly (1983) note that the frogs are occasionally held near fire as part of the treatment.

On the other hand, the southern group of Choco Indians simply wipe their darts across the back of the frog that they use for poison. This is not too surprising, because the frog in question is *Phyllobates terribilis*. This species, first described by Myers, Daly, and Boris Malkin (1978), is reputed to be at least 20 times as poisonous as the two species along the San Juan River.

Most people who use dart poison rely on extracts from plants of the genus *Strychnos*, like curare. Although the poisons that the Choco natives extract from the frogs are more toxic than curare, use of the frog poisons has never been very widespread. This is probably due to the fact that the frogs utilized by the Choco Indians are of extremely limited distribution; other species of their family are less toxic and therefore less useful as a source of dart poison.

The ability to produce toxic defensive skin secretions is not limited to the Dendrobatidae. All frogs and toads are poisonous to some extent. The Dendrobatidae are most widely known for being very toxic. On the contrary, they are interesting also for their peculiar lifestyle, and unusual reproductive strategies.

The dendrobatids consist of four genera: *Atopophrynus*, *Colostethus*, *Dendrobates*, and *Phyllobates*. The seventy or so species of *Colostethus* are relatively nontoxic and have a brown coloration. There are approximately fifty species of *Dendrobates* and five species of *Phyllobates*. All are characterized by very bright warning coloration and are capable of secreting foul-tasting or toxic substances, possibly both, from their skin when stressed.

This ability has fairly obvious adaptive significance. A predator which bites a dendrobatid frog usually puts it down promptly as a result of sensations of foul taste, numbing, or burning in its mouth. Thus there is a certain amount of selection in favor of bad taste. Dendrobatid frogs are not without predators, however. Certain snakes and large spiders are able to eat them.

Poison is secreted through what are known as granular glands, so named because they contain spherical granules. Like the mucus glands among which they are distributed, the granular glands extend from deep in the skin through the pigment layers to the surface of the body. Granular glands are common to all frogs (they appear to be a primitive characteristic), but in some dendrobatids they are capable of secreting a poison that is stronger than curare. Other dendrobatids are less toxic, but are still not a choice food item for most predators.

Dendrobatid frogs produce alkaloid compounds as the active component of their defense secretion. These compounds are usually thought of as being produced by plants, but in reality, dendrobatid frogs secrete a variety of unique alkaloids. They promise to provide years of challenge for biochemists and bemused herpetologists.

Frogs of the genus *Phyllobates* have developed their own characteristic toxin at the expense, so to speak, of piperdine alkaloids. This compound is extremely poisonous and represents a new class, christened batrachotoxins by Myers and Daly. These toxins are the most active agent in the dart poisons of the Choco Indians. (Apparently the toxins are destroyed by cooking because they are poisonous taken internally.)

Batrachotoxins are alkaloids that act on the site of sodium exchange in the membranes of nerve and muscle cells. Normally, impulses are carried along the cell walls of nerve fibers as a sort of depolarization wave: the sodium passes through the cell membrane to the inside and potassium passes to the outside. Immediately, the elements return to their first position, ready to fire off another nerve impulse. This wave of depolarization moves down the nerve cells to the muscle fibers (Schmidt-Nielsen, 1981: 466). Batrachotoxins affect the sites of sodium exchange, causing the nerve and muscle cells to be selectively more permeable to sodium. However, the cells are unable to eliminate the sodium, whereupon the nerves cease transport of information and the muscles remain contracted, resulting in serious heart problems, e.g., arrhythmia, fibrillation, and failure.

Other dendrobatid toxins are somewhat less poisonous, though no less interesting. Some of these, for example pumiliotoxin C and gephyrotoxin, act upon the neuromuscular junction, preventing the release of acetylcholine from the motor nerve endplate. Without acetylcholine, the gap between the nerve and the muscle cannot be bridged, and the electrical impulses cannot pass from the nerve to the muscle (Schmidt-Nielsen, 1981: 491-2).

Similarly, histrionicotoxins act on the sites of acetylcholine release, preventing the transmission of signals to the muscles. They also block potassium from leaving the nerve and muscle membranes, prolonging the contraction of muscle.

When muscles are stimulated, calcium is released from storage sites within its fibers, and binds to filaments within the muscle fiber, freeing the sites of contraction (Schmidt-Nielsen, 1981: 391-3). Instead of blocking this process, pumiliotoxin B enhances it, and also inhibits return of calcium to the storage sites. As a result, the force and duration of contractions within both skeletal and heart muscle are increased.

Having these interesting secretions to protect themselves, dendrobatids are able to utilize ecological niches unavailable to other frogs as, for example, daylight, terrestrial and lower arboreal habitats. They even breed out of water.

Most frogs breed in an embrace called amplexus. The male clasps the female from behind, embracing her with his front legs, while she lays her eggs and he sheds his sperm upon them. Generally, frogs either clasp the female behind the forelegs (axillary amplexus) or in front of the hind legs (inguinal amplexus). Typically, males are smaller than females, hence they need to be positioned far enough back on the female to fertilize the eggs as they are extruded. However, in some dendrobatid species the males are as large as the females; therefore they amplex with the male clasping the female around her head. In other dendrobatid species, no amplexus occurs at all. According to Halliday (1982: 112), *Dendrobates auratus* does not amplex, but breeds with fancy enough footwork that the eggs get fertilized just the same. Myers, Daly, and Malkin (1978) suggest that this is not an isolated phenomenon among dendrobatids.

Female dendrobatid frogs lay far fewer eggs than their aquatic cousins. According to Daly, Myers, and Malkin (*op. cit.*), dendrobatids lay from as few as one or two eggs to as many as forty, a trifle compared to other frogs, who may lay tens of thousands. They offset small clutch size a bit by breeding the year around, yet even so, they lay fewer eggs than most aquatic frogs. The care that dendrobatid eggs and tadpoles are given may help also.

Once their eggs are laid, dendrobatids do not usually abandon them as do most other frogs. Either the male or the female parent, depending on the species, tends the eggs. The "nurse" frog may either guard or periodically visit the eggs. In some species, the nurse frog may moisten the eggs with water from its bladder. Frogs of the family Centrolenidae also guard their eggs but lay them on limbs that hang out over the water (Goin, Goin and Zug, 1978: 18, 242, 243).

The remarkable thing about this portion of dendrobatid natural history is the means by which the larvae reach water. The nurse frog periodically (Myers, Daly and Malkin, 1978) wiggles its hind end among the eggs to moisten them and to permit the tadpoles when they hatch to wriggle onto the adult's back. The adult then carries the tadpoles to water.

Dendrobatid tadpoles have a flat or concave belly, enabling them to adhere to the back of the adult. The adult secretes a patch of mucus that aids in attachment of the tadpoles. In some species this attachment is very strong, whereas in others it is only slight. According to Myers and Daly (1983), the adult may carry the young around on its back for a few hours or a week, depending on the species, until the tadpoles are released into a suitable body of water. The mucoid adhesive being water-soluble, the tadpoles are detached by soaking.

Myers, Daly and Malkin (1978) have performed experiments demonstrating that dendrobatid eggs will develop normally if they are placed in water instead of on land. Nevertheless, the frogs consistently deposit their eggs on land and transport the tadpoles to water. Depending on the species, the tadpoles may be placed in streams, rainwater caught between the stems and leaves of certain tropical plants, or in hollow stumps.

The tadpoles that are placed in the two latter microhabitats are forced to make a living in a very nutrient-poor environment. *Dendrobates pumilio* and *D. auratus* have developed some interesting adaptations to this predicament. In *Dendrobates pumilio*, the nurse frog is the female which returns periodically to the place where she released her tadpoles. She then lays unfertilized eggs into the water to feed the tadpoles. In *Dendrobates auratus*, the nurse frog is the male. Once the tadpoles are deposited in a hollow stump, he abandons them. It is not at all uncommon for only one tadpole to live long enough to metamorphose. Not surprisingly, many species of dendrobatid tadpoles have keratinized beaks and denticles. The *Phyllobates terribilis* tadpole, which has this sort of dentition, apparently thrives in Myers, Daly, and Malkin's lab on a diet of boiled lettuce. This seems to imply that cannibalism is a food shortage phenomenon.

In some dendrobatids, the tadpoles are even preyed on by the adults of their own species. Dendrobatids have even been known to cannibalize their own eggs.

Dendrobatids pay a very high price in energy and effort for reproduction. This is well illustrated and evidenced in a population study of *Phyllobates terribilis* by Myers and Daly (1983). They found that juvenile frogs comprised only an observed 2.5% (they postulated that they might actually comprise 10%) of the total frog population.

In addition to the high reproductive cost, there is another factor that influences population density in favor of adults: predation. Studies of *Phyllobates terribilis* by Myers, Daly, and Malkin indicate that eggs and tadpoles are not poisonous and that the immature frogs are less toxic than adults (and it takes the newly metamorphosed frogs a year to reach sexual maturity). Snakes (*Leimadophis epinephalus*), adult dendrobatids, man and probably some spiders, manage to eliminate a significant portion of the young. Even adults, although highly toxic, are not without predators.

Yet perhaps there is method behind all of this madness. Since the adults have such long lives (5+ years in captivity), and so few predators, the high 'infant' mortality could be necessary to maintain a fairly constant population.

These 'poison frogs', the Dendrobatidae, are much more than a bizarre source of toxins useful to man. They have their own very distinct and fascinating natural history of astonishing complexity, diversity and adaptiveness.

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—Jonathan H. Magid, *Department of Environmental, Population and Organismic Biology, University of Colorado 334, Boulder, Colorado, 80309.*

Received: 10 May 1983

NEWS AND NOTES:

YOU ARE INVITED TO ATTEND

the

Seventh Annual Regional Herpetological Society Symposium

on

Sunday evening, 7 August 1983 and Monday afternoon, 8 August 1983

in

Salt Lake City, Utah

Sponsored by

Society for the Study of Amphibians and Reptiles

and

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EDUCATION AND CONSERVATION PROJECTS OF REGIONAL HERPETOLOGICAL SOCIETIES

SUNDAY, EVENING, 7 August 1983

7:30PM - ? The Regional Herpetological Society Social at the Wasatch Front

MONDAY, AFTERNOON, 8 August 1983

Michael Bishop (The Greater San Antonio Herpetological Society)
"Herpetofauna and the locals"

Eldon Romney and Dave Jensen (Utah Herpetological Society)
"Meeting the Challenges of a small Herpetological Society"

Michael Lambert (British Herpetological Society)
Read by Kraig Adler

"Current Activities of the British Herpetological Society in relation to Europe and the Commonwealth".

Jeffrey Black (Oklahoma Herpetological Society)
"Oklahoma Rattlesnake Round-ups"

Robert Bader (Virginia Herpetological Society)
"Establishing the Range of the Pine Barrens Tree Frog, Hyla andersoni in North Carolina"

Harold DeLisle (Southwestern Herpetologists Society)
"Herps, Sex and Bureaucrats—The problems of captive reptile reproduction for fish and game officials"

Joseph T. Collins (Kansas Herpetological Society)
"Kansas Herpetological Society—ten years of progress"

NEWS AND NOTES:

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Annual Meeting of
The Society for the Study of Amphibians & Reptiles
August 7-12, 1983 Salt Lake City, Utah

Academic Press has recently published volume thirteen of the BIOLOGY OF REPTILIA, edited by Carl Gans in collaboration with F. Harvey Pough of Cornell. This volume deals with topics in physiological ecology. It includes chapters on adaptation to special circumstances, energetics and growth, energy budgets and life histories, and the relationship between the environment and reproductive cycles. Each article is followed by an extensive bibliography.

Academic Press would like to make this volume and indeed the entire series more accessible to members, particularly to student members, of the Society for the Study of Amphibians and Reptiles. To do so we are offering a convention discount of 20% on single copy purchases or a 30% discount on the purchase of three or more books.

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Author: Roger Conant

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Department of Herpetology
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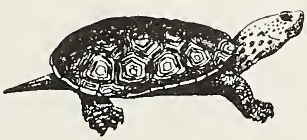
DEPARTMENT OF HERPETOLOGY

THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.



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SEPTEMBER 1983

VOLUME 19 NUMBER 3

BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

Volume 19 Number 3 September 1983

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The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
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Volume 19 Number 3 September 1983

The Maryland Herpetological Society

Department of Herpetology, Natural History Society of Maryland, Inc.

Library of Congress Catalog Card Number: 76-93458

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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

VOLUME 19 30 SEPTEMBER 1983 NUMBER 3

RELATIONSHIPS AMONG IGUANINE LIZARDS (SAURIA: IGUANIDAE) AS SUGGESTED BY APPENDICULAR MYOLOGY

Jonathan C. Oldham and Hobart M. Smith

Abstract

The muscles of the shoulder, brachium and thigh of the iguanine lizard genera *Amblyrhynchus*, *Brachylophus*, *Conolophus*, *Ctenosaura*, *Cyclura*, *Dipsosaurus*, *Enyaliosaurus*, *Iguana* and *Sauromalus* are similar in attachments, location and appearance. Some variation is found in the latissimus dorsi, biceps, triceps, puboischiofemoralis internus, puboischiofemoralis externus, adductor, pubotibialis, iliofibularis, iliotibialis and ambiens. It is concluded that 1) similarities in the myology of the shoulder, brachium and thigh indicate a close relationship among the iguanine lizards; 2) variation in individual muscles is severely limited in establishing relationships; 3) the sum total of variation in appendicular muscles of iguanines indicates a certain few relationships, as follows; 4) *Ctenosaura*, *Iguana* and *Cyclura* are the most closely related iguanines; 5) *Brachylophus*, *Dipsosaurus*, *Enyaliosaurus* and *Sauromalus* are more closely related to *Ctenosaura* and *Iguana* than to each other; 6) *Amblyrhynchus* and *Conolophus* are closely related to *Ctenosaura* and *Iguana* and to each other; 7) *Enyaliosaurus* is generically distinct from *Ctenosaura*.

The Iguanidae is the largest family of New World lizards and has been separated into several phyletic lines (Savage, 1958; Etheridge, 1964). One line consists of nine genera referred to as the iguanine lizards (Etheridge, 1964). The iguanine line includes the following genera: *Amblyrhynchus* and *Conolophus* (Galápagos Islands); *Brachylophus* (Fiji and Tonga Islands); *Cyclura* (West Indies); *Ctenosaura* and *Enyaliosaurus* (México and Central America); *Iguana* (México to Paraguay); and *Dipsosaurus* and *Sauromalus* (southwestern United States and adjacent México).

All the iguanines are basically herbivorous, relatively large as compared with other iguanids. Most are stout-bodied and all exhibit morphological similarities which indicate close relationship inter se. The iguanines, however, exhibit a disjunct distribution and some genera indicate a specialization in habit and habitat preference.

The major purpose of this investigation was to determine whether muscles of the shoulder, brachium and thigh of the iguanine lizards exhibit any systematic significance.

Methods and Materials

Thirty-three muscles of the shoulder, brachium and thigh of the nine iguanine genera were dissected and the physical features of each muscle noted. Features included origin, insertion, number of parts, size and location. A comparison of these muscles among the iguanine genera was then made.

Muscle terminology is based upon the laboratory manual by Oldham and Smith (1975).

The specimens used in this study are located in the collection of the author (JCO) or in the following institutions: Brigham Young (BYU); California Academy of Sciences (CAS); Field Museum of Natural History (FMNH); University of Kansas Museum of Natural History (KU); Los Angeles County Museum (LACM): and the University of Colorado Museum (UCM).

The following list indicates the specimens used in this study.

Amblyrhynchus cristatus

CAS 12012, Hood Island

CAS 12689, Wenman Island

FMNH 37237, Galápagos Archipelago, Tower Island; Darwin Bay

LACM (uncatalogued, no data)

Brachylophus fasciatus

BYU 23743, Fiji Islands

FMNH 60117, Fiji Islands, Viti Levu Island

Conolophus subscristatus

CAS 11403, 11501, 11506, Narborough Island

FMNH 37318, Galápagos Archipelago, Barrington Island

Ctenosaura bakeri

FMNH 53831, Honduras, Bay Islands, Ruatan Island

Ctenosaura hemilopha hemilopha

UCM 51032, Baja California Sur, 2 miles North Todos Santos

Ctenosaura hemilopha macrolopha

JCO (no data)

Ctenosaura palearis

FMNH 20562 (3 specimens), Guatemala, El Rancho

Ctenosaura similis

FMNH 21080, Guatemala, Tiquiste (near Rio Bravo)

Cyclura cornuta

JCO (2 specimens, no data)

Dipsosaurus dorsalis dorsalis

UCM 51044, Baja California Norte, 46 miles North San Felipe

UCM 51046, Baja California Norte, 16 miles North, 9 miles West San Felipe

UCM 51047, Baja California Norte, 4 miles North San Felipe

UCM 51050, Baja California Norte, 31 miles South San Felipe

Dipsosaurus dorsalis lucasensis

UCM 51054, 51055, Baja California Sur, 15.2 miles Southwest San José del Cabo

Enyaliosaurus clarki

KU 29637, México, Michoacán, 9 miles South Southwest Apatzingán

Enyaliosaurus defensor

KU 70262, México, Yucatán, Piste

Enyaliosaurus quinquecarinatus

FMNH 123678, 123681, México, Oaxaca, Tehuantepec

UCM (2 uncatalogued specimens, no data)

Iguana iguana

JCO (4 specimens, no data)

Sauromalus australis

UCM 51077, 50178, Baja California Norte, 4.5 miles North Las Arrastras

UCM 50179, 51080, Baja California Norte, 3.5 miles North Las Arrastras

Results and Discussion

Similarities of the myology of the shoulder, brachium, and thigh indicate a close relationship among the nine iguanine genera. The origin, insertion, location and general shape of each of the thirty-three muscles examined are similar in all genera. Some variation occurs in ten muscles and twenty-five character states can be recognized. A summary of variation is given in Table 1.

TABLE 1

SUMMARY OF VARIATION IN CHARACTER STATES OF IGUANINE MYOLOGICAL CHARACTERISTICS

	LATISSIMUS DORSI Part origin on thoracic ribs		BICEPS Proximal belly absent		TRICEPS Scapulohumeral ligament reduced		TRICEPS Coracoid head receives a tendon from latissimus dorsi	
	Yes	No	Yes	No	Yes	No	Yes	No
Amblyrhynchus		X		X		X	X	
Brachylophus		X		X		X	X	
Conolophus		X	X[a]	X		X	X	
Ctenosaurus		X		X		X	X	
Cyclura		X		X		X		X
Dipsosaurus		X		X		X	X	
Enyaliosaurus		X		X	X		X[b]	X[c]
Iguana		X		X		X	X	
Sauromalus	X		X			X	X	

a - One specimen
b - *E. defensor, E. clarki*
c - *E. quinquecarinatus*

	PUBOISCHIOFEMORALIS INTERNUS Insertion antero-ventral and dorsal		PUBOISCHIOFEMORALIS EXTERNUS Lateral slip attached to pubotibalis		ADDUCTOR Insertion/length of femur		PUBOTIBIALIS Part origin on lateral slip of puboischiofemoralis externus		PUBOTIBIALIS Two heads converge near insertion	
	Yes	No	Yes	No	1/2	2/3	Yes	No	Yes	No
Amblyrhynchus		X		X	X		X		X	
Brachylophus	X			X	X		X			X
Conolophus		X		X	X		X		X	
Ctenosaura		X		X	X		X		X	
Cyclura		X		X		X	X		X	
Dipsosaurus		X		X		X	X		X	
Enyaliosaurus	X[d]	X[e]	X		X[f]	X[g]		X	X	
Iguana		X		X	X		X		X	
Sauromalus		X		X	X			X	X	

d - *E. quinquecarinata, E. clarki*
e - *E. defensor*
f - *E. defensor*
g - *E. quinquecarinatus, E. clarki*

	ILIOFIBULARIS Insertion/length of fibula			ILIOTIBIALIS Partly Divided		AMBIENS Partly Divided	
	1/10	2/10	4/10	Yes	No	Yes	No
Amblyrhynchus			X		X	X	
Brachylophus		X			X		X
Conolophus			X		X	X	
Ctenosaura		X			X	X	
Cyclura		X			X	X	
Dipsosaurus	X				X		X
Enyaliosaurus		X		X			X
Iguana		X			X	X	
Sauromalus		X			X		X

Even in those muscles which exhibit variation, most genera are similar in each myological character and no more than two genera differ from the majority with respect to each character with the exception of the ambiens muscle.

The shoulder and brachial muscles are stable; variation was found in only three: latissimus dorsi, biceps, and triceps. The iguanine latissimus dorsi typically originates by aponeurosis from the seventh cervical to the fifth thoracolumbar vertebra, but in *Sauromalus australis* it has a costal origin (Figure 1).

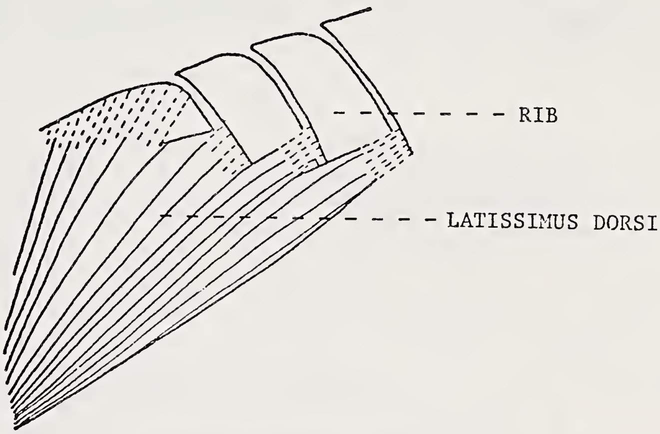

Figure 1. Origin of latissimus dorsi of *Sauromalus australis* (UCM 51080); left side.

The biceps typically exhibits both a fleshy and tendinous origin from the coracoid bone, but in *Sauromalus* and one specimen of *Conolophus* its origin is wholly tendinous (Figure 2).

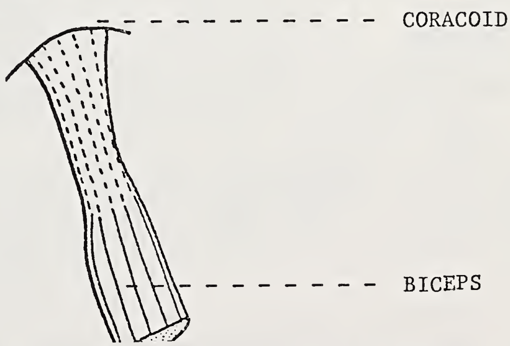

Figure 2. Biceps of *Sauromalus australis* (UCM 51080); left side.

The triceps varies in the nature of the tendons and ligaments associated with it: the coracoid head atypically receives no tendon from the latissimus dorsi in *Cyclura* and *Enyaliosaurus quinquecarinatus*; the scapulohumeral ligament is reduced in *Enyaliosaurus*, especially in *E. quinquecarinatus* where it is extremely small.

The thigh myology is also stable. In *Brachylophus* and two species of *Enyaliosaurus*, one head of the puboischiofemoralis internus inserts on the dorsal surface of the femur, whereas both heads insert anterodorsally in the other genera. The adductor and iliofibularis have a similar insertion in all genera but vary in the position of the insertion in accordance with the length of the femur and fibula respectively (Figures 3, 4).

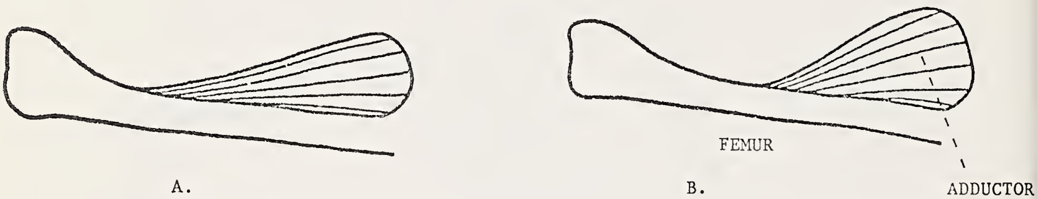

Figure 3. Variation in insertion of adductor, ventral view, right side. A. *Amblyrhynchus cristatus* (FMNH 37237). B. *Dipsosaurus dorsalis dorsalis* (UCM 51050).

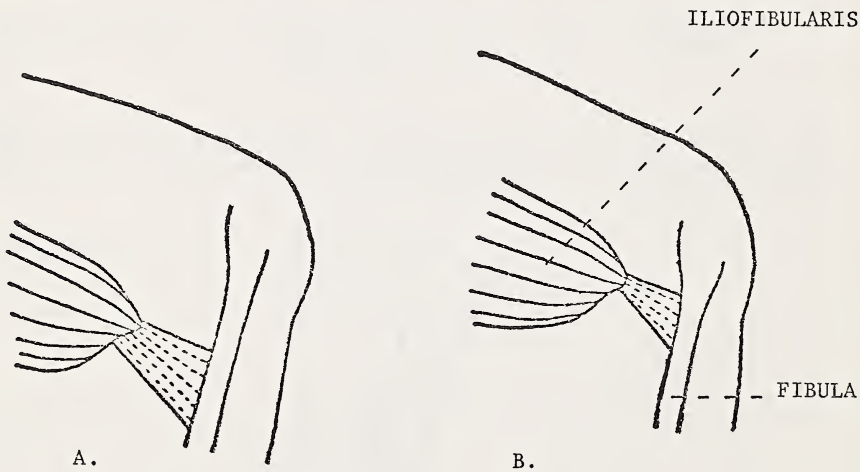

Figure 4. Position of insertion of iliofibularis, dorsal view, right side. A. *Amblyrhynchus cristatus* (FMNH 37237). B. *Dipsosaurus dorsalis dorsalis* (UCM 51050).

The pubotibialis and puboischiofemoralis externus originate on the pubis and are partially connected. In most genera a portion of the pubotibialis originates on the lateral head of the puboischiofemoralis externus. The iliotibialis shows a partial division in *Enyaliosaurus*. The ambiens is partially divided in five genera, undivided in four and is the only muscle useful in grouping the iguanine genera.

Avery and Tanner (1971) attempted to group the iguanines on the basis of similarities and differences in the head and throat musculature. It is apparent that individual appendicular muscles, with the exception of the ambiens, are not useful in grouping iguanines since there is a great deal of similarity. Individual muscles then would not be useful in showing intrageneric relationships. Since variation does not divide the iguanines into groups the deviant character states found in the iguanine appendicular muscles should be considered specialized.

Character states which are considered specialized because they differ from the pattern of the iguanine line are the insertion of the adductor on two-thirds the length of the femur, dorsal insertion on the femur of the puboischiofemoralis internus, partial division of the iliotibialis, insertion of the tendon of the iliofibularis on either the first-tenth or the fourth-tenth of the fibula, no partial origin of the pubotibialis on the lateral head of the puboischiofemoralis externus, a partial costal origin of the latissimus dorsi, absence of the proximal belly of the biceps, and absence of a tendon from the latissimus dorsi to the tendon of the coracoid head of the triceps.

The specializations are found scattered, one or a few to each genus except for *Ctenosaura* and *Iguana*. They differ, in some cases, but slightly from the normal iguanine pattern and represent extreme drift specialization. Partitioning of genera may have occurred early and some of the specializations remained with the particular genus or genera in which they originated.

The ambiens muscle is split in five genera and generally undivided in four. The genera *Amblyrhynchus, Conolophus, Ctenosaura, Cyclura* and *Iguana* have a divided ambiens and these genera correspond to a similar group described by Avery and Tanner on the basis of the position of the cervicomandibularis and levator angularis muscles. *Sauromalus* was also placed in this group. It is notable, however, that the ambiens is divided in the larger-bodied iguanines and is not in the smaller genera *Brachylophus, Enyaliosaurus, Dipsosaurus* and *Sauromalus*.

Variation in the thoracic and head musculature may be phylogenetically significant since variations in these muscles may be influenced by cranial osteology. The pelvic and pectoral girdles are, on the contrary, similar in all iguanines, and this lack of variation is reflected in the constancy of the proximal appendicular muscles.

Although individual muscle variation may be insignificant in showing relationships, the numerical total of difference may be of value. Table 2 gives the total number of myological differences among the iguanines based on variable characters, although certainly not all are independently variable.

TABLE 2

NUMBER OF MYOLOGICAL DIFFERENCES AMONG IGUANINE GENERA BASED ON TWELVE CHARACTERS

	Amblyrhynchus	Brachylophus	Conolophus	Ctenosaura	Cyclura	Dipsosaurus	Enyaliosaurus	Iguana	Sauromalus
Amblyrhynchus	X	4	1	1	3	3	9	1	5
Brachylophus	4	X	5	3	5	4	7	4	5
Conolophus	0	4	X	1	3	3	9	1	4
Ctenosaura	1	3	2	X	2	3	8	0	4
Cyclura	3	5	4	2	X	3	6	2	6
Dipsosaurus	3	4	4	3	3	X	7	3	5
Enyaliosaurus[a]	9	7	10	8	6	7	X	8	8
Iguana	1	4	2	0	2	3	8	X	4
Sauromalus	5	5	4	4	6	5	8	4	X

a - *E. quinquecarinata*

The total number of variations among genera suggests a close relationship among iguanines since the total number of differences between any two genera is relatively small. *Iguana* and *Ctenosaura* are seemingly very closely related since there are no differences between them in the twelve varying myological characters. The other seven genera show fewer differences in comparison with *Ctenosaura* and *Iguana* than in comparison with each other, with the exception of *Amblyrhynchus*, *Conolophus* and *Enyaliosaurus*, indicating a close relationship of all iguanines to *Ctenosaura* and *Iguana*. A close relationship between *Amblyrhynchus* and *Conolophus* is also suggested.

Enyaliosaurus unexpectedly appears to be the most specialized. Historically it has been considered a close relative of *Ctenosaura*, but eight points of difference were found between *Ctenosaura* and *Enyaliosaurus quinquecarinatus*. Perhaps the specialized nature of the habitat of this species accounts for the extensive divergence. *E. clarki* and *E. defensor* are less distinctive from *Ctenosaura* (Table 1). The appendicular muscles of *Ctenosaura bakeri* and *C. palearis* are similar to those of the other species of the *Ctenosaura* examined. It appears that *Enyaliosaurus* is generally distinct from *Ctenosaura* and that the genus consists only of *E. defensor*, *E. quinquecarinatus*, and *E. clarki*. A more complete study of these two genera would be necessary before drawing final conclusions concerning their relationships.

That seven genera are more similar to *Ctenosaura* and *Iguana* than to each other would tend to support a pre-*Ctenosaura-Iguana* ancestry as proposed by Avery and Tanner. The close relationship between *Brachylophus* and *Dipsosaurus* indicated by Avery and Tanner is not supported by the appendicular muscles since a total of four differences in structure was found.

Acknowledgments

We wish to express our gratitude to several persons who made important contributions to this study. T. Paul Maslin, Richard E. Jones, Carl Bock and Igor Gamow provided helpful suggestions. John Lawson assisted in the dissection of specimens and Rowan Hicks drew the illustrations. The following persons provided materials: Earl Brockelsby and Joe Hall of the Black Hills Reptile Gardens, Rapid City, SD; William E. Duellman, University of Kansas Museum of Natural History; Alan E. Leviton, California Academy of Sciences; Hyman Marx, Field Museum of Natural History; Wilmer W. Tanner, Brigham Young University; Ernest E. Williams, Museum of Comparative Zoology; and John Wright, Los Angeles County Museum of Natural History. Financial support was provided by a grant from the Walker Van Riper Fund of the University of Colorado Museum and by a grant-in-aid from the University of Colorado Graduate School.

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Received: 12 October 1983
Accepted: 17 October 1983

MITE LARVAE OBSERVED ON TWO-LINED SALAMANDERS, *Eurycea bislineata*

While leading a creek hike along a tributary of Butler's Branch of Piscataway Creek, near Clinton, Prince George's County, Maryland on 20 July 1983, I noticed a number of northern Two-lined Salamanders, *Eurycea b. bislineata*, with reddish sides. The salamanders were seen in a clear, fast-moving section of the creek near Clearwater Nature Center. Of the five "red-sided" salamanders seen, two were collected and taken back to the Nature Center. The two specimens collected were adult two-lined salamanders, approximately 3 inches in length, with numerous deep red blotches on the sides of the body and on the hind legs. Under a microscope, Naturalist Sam Lyon discovered the red blotches were alive and later identified them as mite larvae. The larvae were approximately .05" x .01", dark red, and had six legs. The microscope was not powerful enough to see any other details. The back legs of one adult was totally infested and swollen to twice normal size. One foot had no toes. The salamanders died soon after they were collected and are catalogued in the collection of the Natural History Society of Maryland.

On previous visits to the same location of the creek, I had collected numerous Northern Two-lined and Northern Dusky Salamanders, *Desmognathus f. fuscus*, but never any with the red blotches mentioned above.

On 26 July 1983, another visit was made to the area. Many Northern Two-lined Salamanders were collected, but none exhibited the red blotchiness seen before.

I would like to thank Sam Lyon, Park Naturalist, Clearwater Nature Center; Tom Partanen, Volunteer; and Herbert S. Harris, Jr., Curator of Herpetology, Natural History Society of Maryland, Inc. for their help and encouragement in the preparation of this note.

—John D. Zyla, *Clearwater Nature Center, Cosca Regional Park, Clinton, Maryland 20735*
The Maryland-National Capital Park and Planning Commission

Received: 3 August 1983
Accepted: 15 August 1983

NEWS AND NOTES:

BOOK REVIEW:

CONSERVING SEA TURTLES. By Nicholas Mrosovsky. 1983. London, 176 pp., 15 fig., 3 tables, 17 pp. ref. Softbound. The British Herpetological Society of London, Regent's Park, London NW 1 4RY. $11.50, postpaid.

In the majority of books, papers and journal articles published on the subject of sea turtle conservation, the focus seems to be more on pragmatics, and less on the evaluation of competing methods and their respective advantages. The problem of trying to conserve the world's sea turtles runs much deeper than many conservationists suggest.

Nicholas Mrosovsky has confronted us with the enormous complexity of this issue, with numerous graphic examples of a challenge yet to be mastered. He provides us with a critical evaluation of the past and present attempts to save and maintain one of the world's most appealing, intriguing, and mysterious creatures. Quoting Peter Pritchard (1980) of the Florida Audubon Society, we are told "....lest we get completely carried away by the conviction that our efforts are indeed saving sea turtles, and fail to maintain a constant critical appraisal of our efforts, it is worth reviewing the different things that people do to try to save sea turtles in order to judge whether these techniques are indeed as purely beneficial as we might think...."

Since "turtles are big," Mrosovsky believes that efforts to save them are becoming increasingly popular, but, alas, of questionable effectiveness. Using this argument, Mrosovsky continually beats the drum that popularity of a technique rarely insures its effectiveness.

Tagging is exemplified as a means of attempting to assist in the conservation effort. Yet Mrosovsky correctly points out that "though widely used, the method has received little scientific evaluation." In essence, this procedure employs the insertion of a metal tag through the skin of the front flipper, with the intention of tracing the migratory paths, geographical range, breeding frequencies, nesting patterns, growth rates, population size, and other useful knowledge necessary to protect species survival.

Robert Bustard, for example, has uncritically accepted the tagging procedure, extolling the tagging programs as having "...provided a wealth of new information and above all there is a good awareness of the plight of the world's sea turtles." Such sanguine remarks are common in the literature, with Mrosovsky wondering how many tags actually stay put, and why such a minimal effort has been expended in designing a tag that will hold up year after year half submerged in sea water, and half buried in flesh.

The virtues and vices of double tagging are explored, with a warning not to view double tagging as an invariably useful device; all too often it ends up in being a mindless, duplicating exercise.

Mrosovsky discusses head-starting, a procedure named by Archie Carr, involving raising hatchlings in captivity, then releasing them, with the unproven belief they will then be larger and less vulnerable to predators, a belief held by Bustard. Even Bustard, however, is forced to admit they often behave more like domesticated animals than wild ones, although they weren't necessarily more vulnerable to predators.

Mrosovsky frowns on the emotional appeal of head-starting, complaining that the moving force behind it ignores the internal logic of the procedure--and not, as he would wish, on external validation.

In point of fact, Mrosovsky finds it extraordinary so many people have embarked on head-starting with such little attention to critical evaluation and to whether such a procedure lends itself to validation at all. The time lag to maturity complicated by tag loss simply multiplies the problem, and, of course, lowers the chances of demonstrating even a modestly successful outcome, Mrosovsky rhetorically asks "...suppose... that even despite tag loss more head-started turtles hauled ashore to nest than would be expected from the number of eggs taken earlier, would that validate the procedure?" Of course he would view such an outcome with pleasure, but he admits that this would not necessarily prove it to be more effective than another procedure, and might obviate looking for more effective procedures that ultimately were cheaper and easier to manage. Still Mrosovsky feels head-starting is a worthy long-term gamble, albeit one the outcome of which this generation may never know.

In reviewing Operation Green Turtle, a much celebrated translocation effort, Mrosovsky acknowledges that it, too, is a large gamble. Translocation involves the taking of hatchlings from their native beach and then releasing them on another unpopulated beach with the fond hope and desire they will return to lay there. A program of the 50's, it is still too recent to evaluate; perhaps we might know something by the end of this decade--but preliminary evidence is discouraging.

Mrosovsky, the iconoclast, cynic, rabid empiricist, and at times cautious optimist, views Green Turtle as a probable failure as a conservation measure, a modestly successful offbeat venture in public relations, and an heroic experimental effort. As Mrosovsky puts it, "Disconfirming a hypothesis is not a failure in science. On the contrary, it is sometimes considered the most instructive of outcomes." Unfortunately Operation Green Turtle was also lousy science--not because the results were negative, but because of the lack of adequate use of controls and poor attention to detail. Mrosovsky argues that as much attention was given to the public relations side of Operation Green Turtle as to the procedural details--O.K. for P.R., but bad as an experiment, and unlikely to lead to useful information that will help to save the sea turtles.

One of Mrosovsky's chapters is titled "The Anathema of Farming," a bit cutesie, but to the point. Mrosovsky informs us that Archie Carr has made light of those who, in the name of conservation, dump cans of turtle soup on the supermarket floor, while applauding their good intentions, and has commented, "If the species does not become extinct, I do not believe the motives of the people who save it will make very much difference an eon or two hence." Mrosovsky, too, defends the turtle farmer, seeing his role, ecologically, as of at least small significance--even possibly beneficial to some degree. Ironically, Mrosovsky, the careful scientist, briefly sounds like Mrosovsky, the entrepreneur, defending the transfer of a few eggs from the beach to the farm while chiding the naïve environmentalists who, like Nero, focus on the fiddle (the farm) while Rome (the overall environment with its accompanying filth) burns. An extreme example is the sad case of the Cayman Turtle Farms, where 4,000 surplus hatchlings had to be sacrificed to satisfy a "proper" ecological balance of the Western Atlantic green turtle populations.

The ever-pessimistic Mrosovsky shocks our conscience, and keeps the reader absorbed by his analysis of the lurching attempts to save Kemp's ridley, the only turtle truly endangered. Although he discusses six other species that invite some concern, Kemp's ridley should clearly be the focus. Mrosovsky derides the many endangered species lists that frequently "cry wolf" too often, and frequently serve to obscure the reality of which species are of the greatest concern not only in numbers, but in relation to the quality of life and the very existence of some peoples.

Perhaps Mrosovsky is creating a bit of a straw man for himself, since the funding of various conservation projects have been so heavily dependent on public appeal. Nonetheless, his scientific caution reminds the practicing herpetologist and conservationist not to climb on the emotional bandwagon, but to stick to his/her scientific ideals by observing, recording, comparing, and evaluating each and every thing he does. Mrosovsky ultimately acknowledges that commerce and conservation are not necessarily antagonistic, and can become partners in a harmonious relationship benefitting all--but the reader is left with an uneasy feeling that our collective breaths should not be held until this harmony is achieved.

—Regan J. Welsh, *Department E.P.O. Biology, University of Colorado, 334 Boulder, Colorado 80309*

Received: 12 October 1983
Accepted: 15 October 1983

NEWS AND NOTES:

Errata: Camarillo Rangel, J. Luis. 1983. New herpetological records from the State of México. Bull. Md. Herp. Soc. 19 (2): 39-46.

Page 39, 2nd paragraph, line 9 - remove *Crotalus durissus* from listing.
Page 40, 1st paragraph, line 6 - : should be;
Page 40, 3rd paragraph, line 1 - seven should read six.
Page 40, 3rd paragraph, line 2 - February should read June.
Page 42, last line - ENEP 1163, 22 June 1981 should read ENEP 1160, 4 July 1981.
Page 43, *D. c. rubidis* should read *Drymarchon corais rubidus*. Its catalogue No. listed ENEP 1176, 24 June 1982 should read ENEP 1691, 22 June 1983.
Page 43, The date for specimen of *C. d. culminatus* should read 20 September 1980 not 1981.
Page 43, last paragraph, line 2 - ENEP 1340, 5 June 1981 should read 5 November 1981.

These corrections/additions were received too late for inclusion in the ms published in the last issue.

—Herbert S. Harris, Jr., *Dept. Herpetology, Natural History Society of Maryland, Inc., 2643 N. Charles St., Baltimore, Maryland 21218.*

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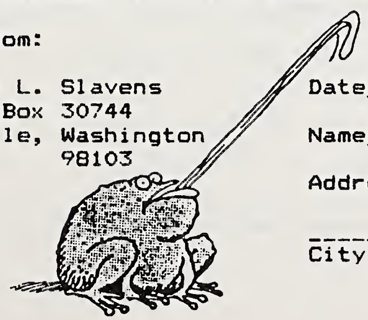

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Published July 1983

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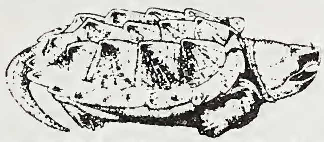

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SATURDAY, 12 NOVEMBER

Noon	-REGISTRATION at Downs Auditorium Entrance
1:00 pm	-WELCOME, Philip S. Humphrey, Director, Museum of Natural History
1:15 pm	-LOUIS GUILLETTE (Wichita). "Reproduction in Kansas lizards (Genera Crotaphytus and Eumeces)." 15 minutes
1:35 pm	-JOSEPH COLLINS (Lawrence). "The spring peeper (Hyla crucifer) in southeastern Kansas." 15 minutes
1:55 pm	-KHS General Business Meeting and Election of Officers, KHS President JOSEPH COLLINS presiding
2:20 pm	-BREAK for Group Photograph by LARRY MILLER on front steps of the Museum
2:40 pm	-PETER GRAY (Lawrence). "The Strecker's chorus frog (Pseudacris streckeri) in southern Kansas." 15 minutes
3:00 pm	-JAMES B. MURPHY (Dallas Zoo). "Husbandry of reptiles in zoological gardens." 45 minutes
3:50 pm	-SLIDE SHOW--Bring your best color slides of amphibians and reptiles, and tell us about them. Limit per person = 25 slides.
5:00 pm	-DINNER BREAK
7:00 pm	-BEER social and AUCTION in BIG EIGHT ROOM of the Kansas Union, next door to the Museum.

SUNDAY, 13 NOVEMBER

9:00 am	-JEFFERY T. BURKHART (Dodge City). "The green toad (Bufo debilis) in western Kansas." 15 minutes
9:20 am	-KELLY J. IRWIN (Topeka). "The alligator snapping turtle (Macroclemys temmincki) in Kansas." 15 minutes
9:40 am	-RAYMOND K. LORAINE (Lawrence). "The present status of the cave salamander (Eurycea lucifuga) in southeastern Kansas." 15 minutes
10:00 am	-LARRY MILLER (Caldwell). "The red-spotted toad (Bufo punctatus) in Barber County, Kansas." 15 minutes
10:20 am	-BREAK for TOUR of Museum's Division of Herpetology, led by RAYMOND K. LORAINE
10:50 am	-SLIDE SHOW: History of the KHS, an extravaganza of color slides depicting our Society's first 10 years. All members are warned to attend this show and defend their reputations.
11:45 am	-JOHN SIMMONS (Lawrence). "Reptiles of the Venezuelan Llanos." 30 minutes
12:20 am	-HAVE A GOOD TRIP HOME, and support your KHS during its next decade. See you at the Silver Anniversary Meeting in 1998.

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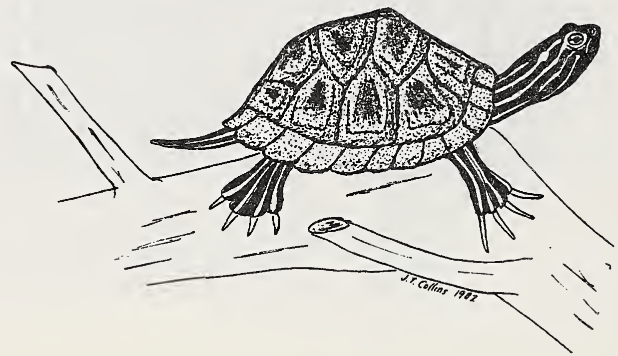

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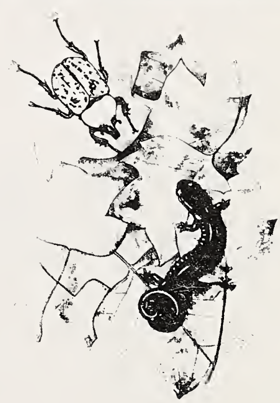

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The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
Baltimore, Maryland 21218

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DEPARTMENT OF HERPETOLOGY
THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.

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EASTERN SEABOARD HERPETOLOGICAL LEAGUE

DECEMBER 1983

VOLUME 19 NUMBER 4

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Volume 19 Number 4 December 1983

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The Maryland Herpetological Society
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BULLETIN OF THE MARYLAND HERPETOLOGICAL SOCIETY

VOLUME 19 31 DECEMBER 1983 NUMBER 4

IMMEDIATE ISC: A NEGLECTED OPTION OF CHOICE IN SNAKEBITE TREATMENT

Jonathan Oldham, Earl Chace and Hobart M. Smith

Abstract

Attention is directed to the efficacy of immediate incision and suction in first aid treatment of snakebite, usually eliminating need for medical treatment and at worst greatly minimizing the trauma of venom action and treatment thereof, if practiced under proper circumstances (an effective bite by a known venomous snake on a body part that can be treated properly) and with a rational attitude (calmly but quickly --within seconds--carrying out the prescribed measures, exercising good judgment without panic).

The medically-approved protocol for snakebite treatment at the present time emphasizes prompt medical attention and minimizes the value of first aid. In our opinion these priorities should be reversed: prompt and proper first aid procedures, where applicable, are of greater urgency than medical attention. They need not significantly impede access to medical aid, but they may greatly minimize its rigor, or completely obviate the need for it at all.

Our thesis is simply that immediate incision and suction properly applied for 15-60 minutes, accompanied after initiation by use of a lymph-restricting constriction band, usually will eliminate need for medical treatment, and at worst will greatly minimize the trauma of venom action and treatment thereof.

It isn't as though the value of incision-suction-constriction band (ISC) measures are unknown; all three of the mostly widely recognized medical authorities on snakebite treatment, as follows, agree upon its effectiveness. Minton (1974:170) noted that "up to 50 percent of the subcutaneously injected dose can be removed if suction is started within three minutes of injection." He goes on to add that, however, "Both experimental and clinical evidence indicate incision and suction is of little value when begun more than 30 minutes after the bite."

Similarly, Parrish (1980:337) stated that numerous "experimental studies...have confirmed the beneficial early use of I.S. [incision and suction] in North American pit viper venom poisoning." He adds (p. 398) that "The sooner it is used, the larger the amount of the venom that can be removed." Russell (1980:269) is the most grudging of the three, recommending incision and suction only if the victim is more than 20 minutes from medical care, and is attended within five minutes after the bite occurred. He prescribed use first of a constriction band, but disclaimed any value of the measures if delayed more than 15 minutes after the injury. He placed more urgent emphasis upon (1) putting the victim at rest, (2) giving him reassurance, (3) immobilizing the bitten part in a functional position, (4) identifying the snake, (5) watching for development of untoward reactions, and (6) arranging for transportation or travel to the nearest hospital.

The steps given highest priority in the preceding list are certainly valid and important, but they do not deal directly with the injected venom, in spite of the fact that all evidence supports the conclusion that the earlier IS is instituted the more effective it is, and the greater the proportion of the venom that can be removed. If 50 percent can be removed if IS is started within three minutes, why cannot a still larger proportion be removed if IS begins within a minute? Why couldn't nearly all of it be removed if only a few seconds are lost after the bite is incurred and before IS is applied? There is absolutely no reason to think that immediate application of IS could not remove most of the venom injected, regardless of the kind of snake involved, whether viperid or elapid. Certainly IS is far less traumatic than the effects of the unimpeded venom will be, even when counteracted, rarely in less than a half hour, by antivenin. Even immediate use of antivenin has greater risks than the relatively minor application of IS, which is now known to require no more than a short (1 cm), shallow (3 mm maximum, just barely deep enough to draw blood), longitudinal incision over each fang perforation, followed by oral suction if no suction cups are available.

The reluctance of medical experts uniformly to recommend use of immediate ISC first aid can be attributed primarily to the irrational behavior that snakebites usually induce not only in their victims but also in their companions. Panic can lead to incisions far exceeding recommended limits, jeopardizing tendons, ligaments, blood vessels and nerves. Serious permanent injury can result, exceeding the damage resulting from a bite not given such first aid. However, Parrish (1980: 398) clearly does not regard IS as a major risk: "I have found this method of first aid to be effective and safe. Only about two to three persons per 1,000 who use incision and suction sever a tendon or a major blood vessel. I am not aware of any deaths resulting from first aid treatment."

Furthermore, 10 to 20 percent of bites do not result in envenomation; immediate ISC is unnecessary in such cases, and creates risks that could be avoided by awaiting development of positive reactions indicating the presence of injected venom.

Our appeal for expert approval of immediate ISC is, therefore, intended only for those victims, or companions, who can calmly and with good judgment apply the recommended measures, following them with the other steps previously listed. Foremost in mind should be the fact that seconds count; speed in making the proper incisions and starting suction is the most important factor in recovery with minimum trauma.

We recognize that in some cases the bite will be where incisions cannot be made properly, or where suction cannot be applied, even when a companion is present. Good judgment must be exercised, requiring clear thinking. Panic has no place in emergencies, and the most risky first aid measures of all, in the presence of panic, are incision and suction. Properly applied, they constitute virtually no risk, even if there has been no envenomation. However, good judgment can make a difference in that context as well; superficial scratches, releases of venom without skin penetration, and bites of harmless snakes should receive no first aid. The victim must decide with minimum delay whether a venomous bite has been received or not. If fang penetration has occurred, and venom has been injected, immediate excruciating pain usually results from most viperid bites. Elapid bites are not immediately painful, except for the purely mechanical injury of the fangs and other teeth, and some viperids cause no immediate pain. Its presence, however, is a reliable indicator that envenomation has occurred, and that ISC should be applied at once. When doubt exists whether envenomation has occurred, if the snake itself is known to be venomous ISC is warranted, if it can be properly applied, for its risk is minimal compared with that of untreated venom.

Although elapid venoms are less easily extracted by ISC than viperid venoms (Minton, 1974:170), they must be dispersed in the same lymphatic channels as any other, hence can be removed by the same procedures (except that, since elapid venoms can penetrate mucous membranes, suction must be mechanical, not oral). Lymph drainage in superficial areas reached by the fangs of all but the largest snakes is toward the skin; this fact is indeed the basis for the effectiveness of shallow incisions - the lymph and the venom it carries, whether viperid or elapid, rises to the subcutaneous areas where it is accessible for removal by suction. For that reason it has very recently been discovered, according to the popular press, that elapid bites can be treated successfully simply by use of a strict lymph-restricting constriction band applied immediately and left in position for some 48 hours, by which time the venom has biodegraded to a harmless level,

as occurs rapidly with all snake venoms when diluted. Viperid envenomation cannot be so treated, because of its strongly cytolytic action, but elapid venoms are, in general, strictly neurotoxic, lacking cytolytic components. Viperid venoms must be removed, or counteracted with antivenin; simply holding them in place, as with a constriction band, permits them to destroy tissues unimpeded. Only strictly neurotoxic venoms can safely be impounded, as it were, until either biodegraded or neutralized by antivenin.

Our aim here is not to deny the validity of the medical profession's evaluation of the merit of various first aid procedures, but to call its attention, and that of potential victims, to the efficacy of immediate incision and suction, in proper circumstances (an effective bite by a known venomous snake on a body part that can be treated properly) and with a rational attitude (calmly but quickly carrying out the prescribed measures, exercising good judgment without panic). Obviously not every case will fall into these circumscribed limits, but those that do can certainly derive tremendous benefits from immediate action. Alternatively, simply to let the venom spread undeterred through tissues progressively more remote from the site of bite assures that, if cytolytic venoms are involved, at least some tissue damage will occur, that the venom will be progressively more difficult to remove mechanically, and that neutralization by antivenin becomes a necessity. And the severity of effects of unimpeded venom, whether cytolytic or neurotoxic, can be formidable, as documented by the many shocking photographs in any of the reference books cited here, and in hundreds of other works.

The clinching evidence that insistence, where proper, upon speedy incision and suction is highly effective, to the extent that active medical attention is seldom needed, is provided by the experience over some 20 years of the first two authors of this account (JO, EC) at the Black Hills Reptile Gardens near Rapid City, South Dakota. In the some 40 years of operation of the Gardens, well over 100 bites have been inflicted upon the snake handlers, virtually all treated by ISC, none resulting in fatalities or permanent disability. A few (three that can be recalled) were hospitalized, two receiving antivenin as well as ISC. No records were kept, so precise figures cannot be given, but the overall picture of efficacy of ISC treatment is clear. In all areas where venomous snakes were handled, razor blades and shoestring tourniquets were concealed, where they could be reached and used within seconds after a bite occurred. All handlers were instructed to carry out immediate ISC on themselves or with the aid of others always within ready call. They were retired to the lounge and kept under observation for several hours, and usually were back at work, little the worse for the experience, the same or next day. To be sure, many of the bites were superficial or from one fang, and often the snake involved had been handled so frequently that venom injection might be minimal. Yet most were not fed abundantly, and had a good supply of venom. They were not milked for venom, although the fangs were demonstrated and in the process some venom was extruded.

Despite these limitations - absence of accurate records or knowledge of the severity of bite - the record in so many cases of prompt recovery through use of ISC, with rare need for medical attention, is very impressive and highly suggestive that immediate ISC is a treatment of choice, where and when appropriate. Authoritative medical approval of that policy is much to be desired, and we are confident would be justified by controlled experiments designed to test definitively the influence of time, within the first three minutes after a bite is inflicted, upon the effectiveness of ISC.

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THE SPECIFIC NAME OF THE GROUND SKINK OF NORTH AMERICA

Hobart M. Smith, Michael J. Preston, and Rozella B. Smith

Abstract

The specific name of the Ground Skink is properly spelled *lateralis* in association with *Scincella* or any other feminine or any masculine nominal genus. The 1977 draft of the next edition of the International Code of Zoological Nomenclature incontrovertibly precludes replacement of *S. lateralis* as a junior secondary homonym of *Scincus lateralis* (Thunberg) Daudin, and therefore leaves *Scincus unicolor* Harlan unavailable in its status as a junior subjective synonym of *Scincus lateralis* Say.

The Ground Skink, first named and described by Say as *Scincus lateralis* in 1823, has in its 160-year history had its specific name assigned to numerous nominal genera, of not only masculine (e.g., *Scincus* itself) but also feminine (e.g., *Scincella*) and neuter (e.g., *Lygosoma*) gender (Brooks, 1975). In the process the termination of the specific name has been changed from the original *-is* to *-e*, in order to agree with the gender of its associated generic name. The currently accepted combination, *Scincella lateralis*, first proposed by Greer (1974) and adopted by Brooks (1975), Behler and King (1979), Smith and Brodie (1982), Collins et al. (1982), and most other recent works, is still open to question, since Mittleman (1950) himself, in proposing the generic name *Scincella*, with its type species of Say's *Scincus lateralis*, used the combination *Scincella laterale*, in spite of the obviously feminine gender of his generic name, undoubtedly in perpetuation of the ending that had been in use for a century or more in association with the neuter generic names of *Lygosoma* or *Leiolopisma*. An additional doubt concerning the proper termination is posed by the citation in the sixth edition of the North American checklist (Schmidt, 1953:147) of *Scincus laterale* for Say's original spelling of the name. In an attempt to determine the proper form of the specific name, at the behest of Dr. Douglas Rossman, we conclude that the combination *Scincella lateralis* is grammatically and orthographically correct, and that the ending of the specific name is flexible in accordance with the gender of the generic name with which it may at any given time be associated - *lateralis* with masculine or feminine generic names, *laterale* with neuter names.

The International Code of Zoological Nomenclature (Art. 11g) specifies that species-group names (specific and subspecific names, often collectively referred to as "trivial" names or "epithets", neither sanctioned by the International Commission on Zoological Nomenclature) can be either adjectives in the nominative case, agreeing in gender and number (always singular) with whatever generic name they are used with, or nouns. Nouns, in turn, can be in the nominative singular standing in apposition with the generic name but not modifying it, or in the genitive singular; in either case they never change endings regardless of the gender of the generic name they are used with.

In examining Say's name in the context of those rules, it is first important to establish incontrovertibly the spelling he used; it was with the ending *-is*, not *-e*. The same name, *lateralis*, was proposed by Say in the same work for a new species of mammal of the genus *Sciurus*. No explicit statement was made in either case whether the name was intended as an adjective or noun, and the ending itself provides no certain clue. It could have been proposed as a third declension noun in the genitive case, for which the *-is* ending is appropriate, and as such the nominative singular ending *-e* is conventional for words of that genre - e.g., *centrale, dorsale, laterale, ventrale* -- although most of those terms are of Neolatin origin and are not found in classical Latin dictionaries (*ventrale* is the only exception). All these words are nouns, and adjectival use does not occur in classical Latin. Say clearly did not use the name as a noun in apposition with the generic name, or else its ending, in the nominative singular, would have been *-e*.

Nevertheless Say could well simply have used the noun as an adjective -- a practice acceptable in Neolatin as well as English. As such it would fall into the third declension group in which the *-is* ending is appropriate in both masculine and feminine gender, *-e* for neuter, in the nominative singular case.

In no way is it possible to know in which context -- as a noun in the genitive case, or as an adjective in the nominative singular, modified from a noun -- that Say proposed the name *lateralis* in either *Scincus* or *Sciurus*. However, authors have universally assumed that the adjectival use was intended, and it is best to maintain that interpretation in the interest of nomenclatural stability. So accepted, the *-is* is correct whether the associated generic name is of masculine or feminine gender; a neuter generic name would require an *-e* ending. Even were the name *lateralis* interpreted as a noun in the genitive singular, its ending would remain the same with either masculine or feminine generic names; the only difference in ending from interpretation as an adjective would come in association with neuter generic names: the ending for the adjective would be *-e*, whereas for the noun it would remain the same, *-is*.

Thus in association with *Scincella*, or any other feminine or with any masculine generic name, the spelling *lateralis* is correct for the Ground Skink. It is noteworthy that the *-us* and *-a* endings so familiar in biological nomenclature in the nominative singular, as either nouns or adjectives, are not be to used in any instance with any of the third declension nouns, or their derived adjectives, ending in *-e*.

The security of Say's name has been threatened only once, by Stejneger's (1934) resurrection of *Scincus unicolor* Harlan (1825), as *Leiolopisma unicolor*. Although, as pointed out by Brooks (1975:2), Harper (1942:180) rejected Stejneger's actions, a reexamination of the problem in the context of current rules of nomenclature is in order.

The basis for Stejneger's rejection of *Scincus lateralis* was the existence of a senior secondary homonym (i.e., not in its original genus), *Scincus lateralis* (Thunberg, 1787), originally *Lacerta lateralis*, now a junior synonym of *Chalcides o. ocellatus* (Forskal, 1775); Daudin created the combination *Scincus lateralis* (Thunberg) in 1803, but it was short-lived - the homonymy does not now exist, nor was it a case of primary homonymy (both specific names proposed in the same nominal genus, regardless of subsequent allocation; junior primary homonyms are permanently, categorically invalid and unavailable; they are "stillborn"). At the time that Stejneger wrote no explicit rule existed for treatment of expired (that is, no longer current) junior secondary homonyms; some workers (Stejneger included) regarded any junior secondary homonym, current or not, as unavailable, whereas others (e.g., Harper, 1942) regarded only current junior secondary homonyms as unavailable. Following Stejneger's view, the next available name had to substitute for Say's, and that was *Scincus unicolor* Harlan (1825).

An explicit ruling appeared in the 1961 edition of the International Code of Zoological Nomenclature, Art. 59, stating that a junior secondary homonym must be rejected if the species-group taxa involved are considered congeneric, but that a name thus replaced after 1960 is to be revived when and if the species-group taxa are subsequently regarded as allogeneric. The uncertainty of application in the case of Say's species remained, however, since after Harper's note appeared in 1942 virtually all works reverted to use of *lateralis* (or *laterale*), and have continued to do so up to the present time; the only notable exception is the fifth edition of the checklist of North American amphibians and reptiles (Stejneger and Barbour, 1943). The problem was finally resolved by the 1977 draft of the new edition of the Code (p. 41), which states that although as a rule a junior secondary homonym replaced before 1961 is permanently invalid and cannot be treated as valid, if use of its replacement is contrary to customary practice, the junior secondary homonym is to be accepted as valid.

That ruling definitively validates the name *Scincella lateralis* over *S. unicolor*; hence both its validity and orthography can be regarded as secure under facts as now known.

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NEWS AND NOTES:

BOOK REVIEW:

LOS REPTILES DE CHIAPAS. Tercera Edición, corregida y aumentada. By Miguel Alvarez del Toro. Tuxtla Gutierrez, Chiapas, México, Instituto de Historia Natural, Apartado Postal Num. 6, Codigo Postal 29000. 248 pp., frontis., 168 figs. (108 in color), paperback. 1982.

For over forty years Miguel Alvarez del Toro has studied the terrestrial vertebrate fauna on site in Chiapas, in the field and in the zoo that is the most notable part of the Instituto de Historia Natural, of which he has long been Director, in Tuxtla Gutierrez, Chiapas, Mexico. An ardent field man, he knows Chiapas, perhaps the most speciose state of that most speciose country in the world, converted to area proportion, better than anyone else. A member of that most elite group of all-around naturalists, he represents a vanishing breed in a world inevitably becoming dominated by specialists as the tidal wave of information rapidly exceeds the capacity of any one person to absorb it all in such broad fields as vertebrate zoology. His books include accounts of the birds of Chiapas, of the mammals of that state, of its wild animals, of the crocodilians of the country, and now, in its third edition, the reptiles of the state. Not content with reviews of most of the terrestrial vertebrates, he has in preparation an account of the spiders of Chiapas, and a historical review of the ecology of the state before the extensive exploitation of the past few decades. A witness to the tragic acceleration of man's impact upon the natural resources of the area, he has become a dedicated conservationist, as evidenced in every publication.

The third edition of his review of the reptiles of Chiapas is a culmination of his work on this group of vertebrates, incorporating all information of the preceding two editions, of 1960 and 1973, adding new information acquired since then, and above all providing color photographs of many species, none previously illustrated in color in the earlier editions.

The format of the third edition is not as imposing as that of the second, being paperbacked instead of hardbound, of smaller over-all dimensions (21 x 16 cm), and printed on thinner paper (about 1 cm), but the reader is still getting much more than in the earlier editions. The text is extensively the same, but the illustrations are far more numerous, over half in color.

Every reptile species and subspecies known from the state is dealt with. The checklist, with range of each taxon in the state, that concludes the book (save for a bibliography and index) contains 206

different species - group taxa. As noted by the author, that catalog is far from complete; every year sees several additions. The ultimate total is likely to exceed 225 and may approach 250.

Clearly this work is essential for anyone concerned with the herpetofauna of Mexico or adjacent Central America. Although lacking critical descriptions, it does contain a wealth of information on color in life, distribution and general natural history. It is a fitting memoir by the greatest vertebrate zoologist now active in Mexico.

—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado, 334, Boulder, Colorado 80309*

Received: 7 November 1983

NEWS AND NOTES:

BOOK REVIEW:

THEIR BLOOD RUNS COLD. By J. Whitfield Gibbons. 1983. University of Alabama Press, P.O. Box 2877, University, Alabama, 35486-2877. xv, 164 pp., ill. $9.95.

A book may qualify as readably good (as opposed to valuable as a reference) in any of several ways. One way is to reveal a little of the author - his personality, mores, views, strengths and weaknesses -- at least as seen through his own potentially biased eyes. A mere peephole may be provided, or a picture window, or anything in between, and that in itself is revealing. We get a rather generous glimpse of an ebullient, straight-talking, colorful raconteur in this book -- a man of action little burdened with indecision, but intelligent enough to learn from his mistakes and to pursue his holy grail of "why?" as best he can, come hell or high water, to his dying day. Articulate and enthusiastic, exuding self-confidence despite full awareness of his own frailties, he is contagiously persuasive as is evidenced not only in his book but in his long association with one of the largest explicitly ecological field research facilities in the country and the staggering number of his intricately co-authored publications emanating from it.

Yet this book is not overwhelmingly autobiographic; enough comes through to give sparkle, the touch of humanity, to a subject that could otherwise well be forbiddingly dry. It is a well-balanced relation, inspired by courageous frankness in portrayal of spontaneously irrational behavior as well as thoughtful insights, all even-handedly recounted in good humor, and by an originality of expression throughout, beginning with the no doubt Truman Capote-inspired title of the book and the very unconventional chapter titles or subtitles.

The subject is really herpetology, but not from the hackneyed viewpoints of the systematist, enamored of classification and distribution; nor of the anatomist or physiologist, preoccupied with structure and function; nor of the terrarist or breeder, concerned with husbandry; nor of the believe-it-or-not-Ripley school, seeking to amaze; nor of the natural historian cataloging the facts of life. These aspects have been exploited repeatedly in numerous books that now tend to repeat themselves extensively.

Gibbons' book is cut from a wholly different cloth and is a breath of fresh air in the flood of recent books on various aspects of herpetology. Its message is predominantly ecological, from beginning to end, although after an introductory chapter, the next six deal seriatim primarily with snakes, turtles, crocodilians, lizards, sala-

manders and anurans. The next three chapters give free rein to the message and some techniques of applied ecology and should be required reading for beginning students in the latter field.

The final chapter is a recipe for herpetological PR: "Teaching the Public: How to Hold an Audience with a Snake." No mincing of words.

A rather astonishingly thorough selection of references follows on the next eleven pages, citing eleven technical journals (seven foreign) in herpetology, and a number of state and regional field books, textbooks (two of U.S.), general works, and world regional accounts arranged by region and country. Thankfully there is a very good index (7 pp.).

Although ecology-oriented, the book is not a text. It is a glimpse for general consumption of the seemingly fathomless cosmos of ecology, be one's interest herpetological or not. One might wish in that context for more references to additional sources in ecology, both general and special. Even for many herpetologists it is a rewarding exercise, at least as an insight into Gibbons' approach to ecology -- a major influence in current research -- if not in addition as a revelation (as to the present reviewer) of an unfamiliar facet of herpetological endeavor. No reader can fail to be fascinated with the book's vivacity and originality as well as the profundity of its subject.

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Received: 7 November 1983

NEWS AND NOTES:

BOOK REVIEW:

THE WORLD OF LIZARDS. By G. Earl Chace. Dodd, Mead and Co., 79 Madison Avenue, N.Y., 10016; 144 pp., ill (monochrome). $10.95. 1982.

A spate of books on reptiles and amphibians, all aimed for the popular market, has been published in the past decade or so. The standard emphasis has been upon care in the home as "pets," giving attention to general natural history primarily as related to husbandry. Chace's new book is a refreshing departure from the norm. It is frankly natural-history oriented, aimed for the general reader, not children, although a serious high-schooler could handle it.

The natural history is not, however, as has become popular in recent years, organized by its own topics, but taxonomically. After a brief (9 pp.) introduction reviewing general information about lizards, twelve of the larger families are discussed seriatim, a chapter for each, covering the bulk of the book (about 105 pp.). In one following chapter four other families, all relatively obscure, are briefly discussed (5 pp.); included are the Amphisbaenidae, here placed with lizards, and the Anniellidae, Pygopodidae and Xenosauridae. Two families, presumably the Lanthanotidae and Dibamidae, are explicitly (p. 21) omitted as too rare to warrant coverage even in this fairly detailed review of lizard biology. Three pages of a final chapter are donated to *Sphenodon*, not because it is a lizard (Chace makes plain that it is not), but because it looks much like one. A three-page bibliography follows, and the book ends with an excellent six-page index giving scientific names as well as the vernaculars used in the text.

The family sequence in the body of the book (Varanidae, Chamaeleonidae, Iguanidae, Gekkonidae, Agamidae, Teiidae, Helodermatidae, Anguidae, Xantusiidae, Scincidae, Cordylidae, Lacertidae) presumably reflects appeal; it is not systematic, nor correlated with animal size, distribution, number of species or diversity.

For no family is there any attempt to review all species or major groups. The biology of the family as a whole is the focus of interest, with citation of given species or genera as examples of given aspects. Much of the account is drawn from the author's experience as curator of reptiles for over twenty years in the highly popular, major tourist attraction of the Black Hills Reptile Gardens near Rapid City, South Dakota. A great deal is drawn from the literature, however, and is reasonably up-to-date.

The text flows smoothly, for Chace is an experienced free-lance writer with several natural history books, popular magazine articles and a newspaper nature column to his credit. Like most science writers, he sought the expert critiques of professional colleagues before submitting his work for publication. Hence there is a minimum of factual error, and he has fabricated as informative an account, fascinatingly told, as could be compressed into the small space provided. It is not a technical, exhaustive review, nor was it intended to be, but as a brief, informative, well-written introduction to lizard biology for the non-specialist it has no peer.

The book is well illustrated with 67 monochrome photographs scattered through the text, and two color photos on the dust jacket. The type font is small but the lines are virtually double-spaced for comfortable reading. The proofing was excellent; very few typographical errors persist.

In all respects the book is pleasing to the eye, to the touch (solidly bound but readily held open) and to the intellect. It can be highly recommended for the general reader with an interest in vertebrate biology, or for the precocious budding herpetologist.

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Received: 14 November 1983

NEWS AND NOTES:

WORKSHOP ON AMPHIBIAN LARVAL BIOLOGY

A teaching workshop on Amphibian Larval Biology will be held at the 1983 joint meeting of the American Society of Ichthologists and Herpetologists, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles, University of Oklahoma, Norman, July 30, 1984. The workshop is designed as a minicourse for the non-expert on these organisms; no prior experience in herpetology or systematics is presumed. Among the people who may be interested in this workshop are general biologists, graduate students in herpetology outside of amphibian biologists, freshwater ecologists, developmental biologists and amateur herpetologists. The workshop will include the examination of museum specimens. A syllabus with annotated bibliography will be provided for all those who register. For more information contact:

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NEW BOOK RELEASE:

News Release

University of Massachusetts Press Post Office Box 429, Amherst, Massachusetts 0100 4 Telephone 413-545-2217

Release: immediately

A new publication by the University of Massachusetts Press:

AMPHIBIANS AND REPTILES OF NEW ENGLAND: HABITATS AND NATURAL HISTORY
Richard M. DeGraaf & Deborah D. Rudis Drawings by Abigail Rorer
112 pp., $14 cloth, $6.95 paper

A richly illustrated guide to New England reptiles and amphibians has just been published by the University of Massachusetts Press. Entitled AMPHIBIANS & REPTILES OF NEW ENGLAND: HABITATS & NATURAL HISTORY (hardcover $14, paper $6.95), the book is co-authored by two wildlife biologists at the U.S. Forest Service unit in Amherst, Massachusetts, Richard M. DeGraaf and Deborah D. Rudis. Illustrations are by Abigail Rorer, a resident of Petersham, Massachusetts.

According to the authors, while there are numerous species of amphibians and reptiles living in New England and the northeastern United States, few people are aware of their existence or know much about them. This book provides information on the natural history, habitat associations, and distributions of 56 species of salamanders, frogs, toads, turtles, and snakes of the New England region. Included is a detailed account of each species' range, relative abundance, habitat, breeding period, home range and movements, and food habitats. DeGraaf and Rudis stress that these species constitute a valuable resource requiring and deserving conservation measures and urge that reptiles and amphibians be considered in wildlife management policy. The book will interest land-use planners, wildlife biologists, foresters, ecologists, herpetologists, students in natural resource management, and lay naturalists.

Born in Attleboro, Massachusetts, Rudis received a B.S. in Wildlife Management from the University of New Hampshire. DeGraaf, who lives in Belchertown, Massachusetts, received a B.S. from Rutgers University and a Ph.D. from the University of Massachusetts. He is co-author of TREES, SHRUBS, & VINES FOR ATTRACTING BIRDS: A MANUAL FOR THE NORTHEAST (paper $10.50), published by the University of Massachusetts Press in 1979.

NOTES:

EASTERN SEABOARD HEEPETOLOGICAL LEAGUE SEMI-ANNUAL MEETING

On 17 March 1984 the Virginia Herpetological Society will be the host for the spring meeting of ESHL. The meeting site will be at The College of William and Mary, Williamsburg, Va.. The program will be held in Swen Library. Parking will be off Route 5, in front of Morton Hall.

Registration will begin at 10:00 A.M.. There are several restaurants and motels within walking distance of the campus.

In order to help pay for the meeting an auction or raffle will be held during the afternoon. Books, art work and other herpetological objects will be offered. NO LIVE ANIMALS!

Before the meeting and afterwards there will be an open house at the college's excellent greenhouse.

A 2x2 slide projector will be available. If an overhead machine, movie projector or any other type of audio-visual equipment is needed please contact Dr. Brooks before 17 March.

For more information about the meeting contact:

Bob Bader
Rt. 2, Box 78
Brookneal, Va. 24528
804-376-5191

Dr. Garnett Brooks
Dept. of Biology
The College of William and Mary
Williamsburg, Va. 23185
804-253-4284

NOTES:

TENTATIVE SCHEDULE

10:00-11:00 a.m. - Registration.
11:00-11:15 a.m. - Opening remarks.
11:15 a.m.-12:00 p.m. - Dr. Joseph C. Mitchell, University of Richmond, Richmond, Va. "Population Ecology and Demography of Two Species of Freshwater Turtles in an Urban Lake."
12:00-12:45 p.m. - Alvin Braswell, North Carolina State Museum of Natural History, Raleigh, N.C. "Natural History of the Mole Salamander *Ambystoma talpoideum*."
12:45-1:30 p.m. - Dr. A.J. Bullard Jr., Mt. Olive, N.C. "Fifteen Years of Observation of the Southeastern Hylids in a Semi-natural Enclosure."
1:30-1:45 p.m. - Break and ESHL representatives meeting.
1:45-2:15 p.m. - Auction or raffle.
2:15-3:15 p.m. - Patricia Riexinger, New York State Department of Conservation, Albany, N.Y. "The Wetlands Project."
3:15-4:30 p.m. - Dr. Elliott Jacobson, University of Florida, Gainsville, Fla. "Veterinary Practices in Herpetology."

Addendum

Clark M. Shiffer, Herpetology and Endangered Species Co-ordinator, Pennsylvania Fish Commission, Bellefonte, Pa.

Society Publications

Back issues of the Bulletin of the Maryland Herpetological Society, where available, may be obtained by writing the Executive Editor. A list of available issues will be sent upon request. Individual numbers in stock are \$2.00 each, unless otherwise noted.

The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at \$.25/page.

Information for Authors

All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8½ x 11 inch paper, with adequate margins. Submit original and first carbon, retaining the second carbon. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016. Price is \$6.00.

Reprints are available at \$.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

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